SCIENCE

30 January 1959

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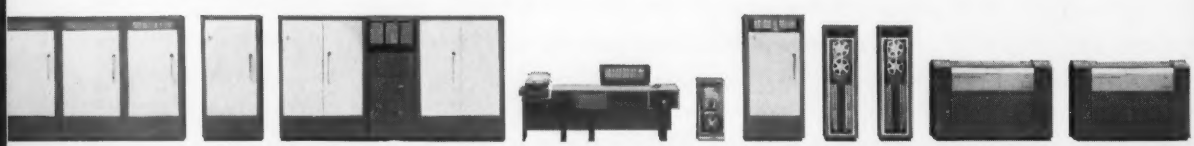

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Letters

Under Secretary of Commerce for Transportation

In your issue of 26 December 1958 there is an editorial concerning the report of the Bureau of Standards on a battery additive. Referring to a resolution introduced by Representative John J. Allen, Jr., of California, now Under Secretary of Commerce for Transportation, the editorial notes that if Allen's appointment is confirmed he "will be in a sense in the unusual position of being simultaneously plaintiff and defendant."

In fairness to Under Secretary Allen, you should know that his duties as Under Secretary of Commerce for Transportation do not include supervision of the Bureau of Standards. Allen's statement on behalf of the resolution which he introduced in 1957 reads, in part, as follows:

"Under the circumstances, and without having any opinion as to the merits of the further claims of the claimants nor the amount thereof, I felt that the claimants should have a day in court in which they could be fully heard . . ."

It might also interest you to know that in March of 1953 when the director of the Bureau of Standards, Allen V. Astin, had been requested to resign because of his findings in the case of the Battery Additive AD-X2, I intervened with Secretary of Commerce Sinclair Weeks in Astin's behalf and the Secretary reversed the position which had been taken by the department with respect to Astin.

LEWIS STRAUSS
U.S. Department of Commerce, Washington, D.C.

I am glad to have the record set straight. When I was checking on the facts for the editorial, I telephoned the public information office of the Department of Commerce and the White House news office. In both instances, I asked whether it was true that the President had announced his intention to appoint John J. Allen, Jr., to the post of Under Secretary of Commerce; the reply from each was, "Yes." Since neither office knew to what use I wished to put the information, it is understandable that they did not give the full title.—G. DuS.

History of Public Health

My attention has been called to a review of my book, *A History of Public Health*, in *Science* [**128**, 1080 (1958)]. While the lengthy review by Leland W. Parr is highly complimentary, it does contain a specific misstatement of fact that I wish to correct, as well as a comment that should be placed in proper perspective in order to guard against misinterpretation.

Parr's statement that I make no mention of toxoid is untrue. He refers specifically to diphtheria, and how he could have missed this is not clear to me. The development of diphtheria immunization is discussed on pages 336 to 338. On page 337, after mention of Ramon's development of anatoxin (toxoid), there is a specific statement that "later, alum-precipitated toxoid was found to have still greater antigenic potency." Discussion of the application and consequences of preventive immunization in diphtheria follow. Diphtheria is used as an example of the consequences of the bacteriological discoveries.

The second item concerns Table III, a listing of certain disease organisms discovered between 1880 and 1898. Parr comments: "I do not see why the anthrax bacillus (1876, Koch) was not included, since it was in a way the fuse that touched off the era, and for that matter the gonococcus, the meningococcus, and the organisms that cause whooping cough, tularemia, relapsing fever, and syphilis might well have been included because of their importance." As Parr himself is aware, the table covers only the last two decades of the 19th century and lists organisms discovered during this period. Koch's work on anthrax is considered extensively on pages 312 to 314, immediately preceding Table III. Mention is also made of the gonococcus, which was discovered in 1879, and of the organism of relapsing fever (1868–1873). Within the context, the story is clear to any reader who pays attention to the text, for which the table is only an illustration.

It should be clear that this is a history of community action in the interest of health and not a history of bacteriology and immunology, the latter subject having been dealt with fully by Bulloch. The selection of data will of course differ with the person who writes a book. I believe that the argument of the book, as I have indicated above, is clear enough.

GEORGE ROSEN
School of Public Health and Administrative Medicine, Columbia University, New York, New York

I did not miss Rosen's mention of diphtheria toxoid (page 337)—in fact I underlined it for review comment. I made an unfortunate choice of words in commenting, to which the author rightly objects. My apologies. Rosen did *mention* diphtheria toxoid as a late development in the fight against diphtheria described. This fight was, however, a campaign in which diphtheria toxin-antitoxin was utilized almost entirely. Toxoid did not replace toxin-antitoxin mixture until somewhat later.

I meant to indicate my regret that the author had not discussed toxoids and, in

particular, the use of tetanus toxoid in recent years. No tetanus toxin-antitoxin mixture has ever been used, and the use of toxoids in the immunization program represents a change of technique and an improvement in accomplishment worthy of record.

Universal immunization with tetanus toxoid would free us from that disease, as the Armed Forces experience has demonstrated. Each one of us is a potential, if not too likely, case of tetanus as a result of the accidents of home, field, shop, school, travel, combat, or recreation. All such injuries of any importance at all are usually treated with an injection of tetanus antitoxin—a serum which, if it protects, does so for one time only, and which may confer serum sensitivity on an individual or even induce an attack of serum sickness. Toxoid lacks these undesirable qualities, and in particular it confers an immunity of substantial duration. Properly given, it obviates the need for antitoxin. I feel that for adults tetanus toxoid is the most valuable vaccine now in use and that at the childhood level tetanus and diphtheria toxoids share honors in importance with the bacterial vaccine for whooping cough and the virus vaccines for smallpox and poliomyelitis.

Comment was made concerning Table III because I felt the title was not a happy one. The author does not bring that point into the discussion. If he wishes to present a table covering an era limited to the last two decades of the 19th century that is his privilege, and I should not propose admission to the group of the anthrax bacillus, which, no matter how many other virtues it may have as a scientific landmark, obviously does not belong. By the same token, of course, the leprosy bacillus should be removed from his table, since G. A. Hansen's paper appeared in 1874.

I agree wholeheartedly with the final paragraph of Rosen's letter.

LELAND W. PARR
George Washington University, Washington, D.C.

Names for Binary Numbers

In "A system of names for binary numbers," [*Science* **128**, 594 (1958)], Joshua Stern proposes a nomenclature to aid users of binary arithmetic to "think binary." Despite the utility of the system for small numbers, Stern concedes that long sequences of syllables become awkward at rather small numerical magnitudes and that recourse must be had to calling off the sequence of digits.

However, long binary sequences *can* be communicated (and remembered) economically by a better technique than calling off digits. This method, widely used by computer engineers, consists of dividing the number into groups of three digits, replacing each group by the corresponding digits from zero to seven, and using the resulting octal-based number. Groups of three, rather than four, digits must be used, for we do not have convenient single-element symbols for all quantities up to fifteen.

Thus, to use one of Stern's examples, the number 87_{10} or $101,0111_2$ (bruonedag bruapone) would be divided $1,010,-111_2$ and read as 127_8—or one (octs^2), two (octs), seven—where (octs) represents 8_{10} units, (octs^2) represents 64_{10} units, and so on. I leave to Stern, with his "ap"titude for naming digits, the selection of names for these quantities. His term "cid" might be used for the first power of eight, of course.

A minor difficulty with the nomenclature proposed by Stern is the use of the nonphonetic English word "one" in the midst of sequences of unfamiliar phonetic terms. This leads to pronunciation difficulties for English speakers, and would not endear the system to non-English speakers. I suggest that the phonetic term "bit," with its useful connotations, might be employed instead of "one," without undesirable consequences.

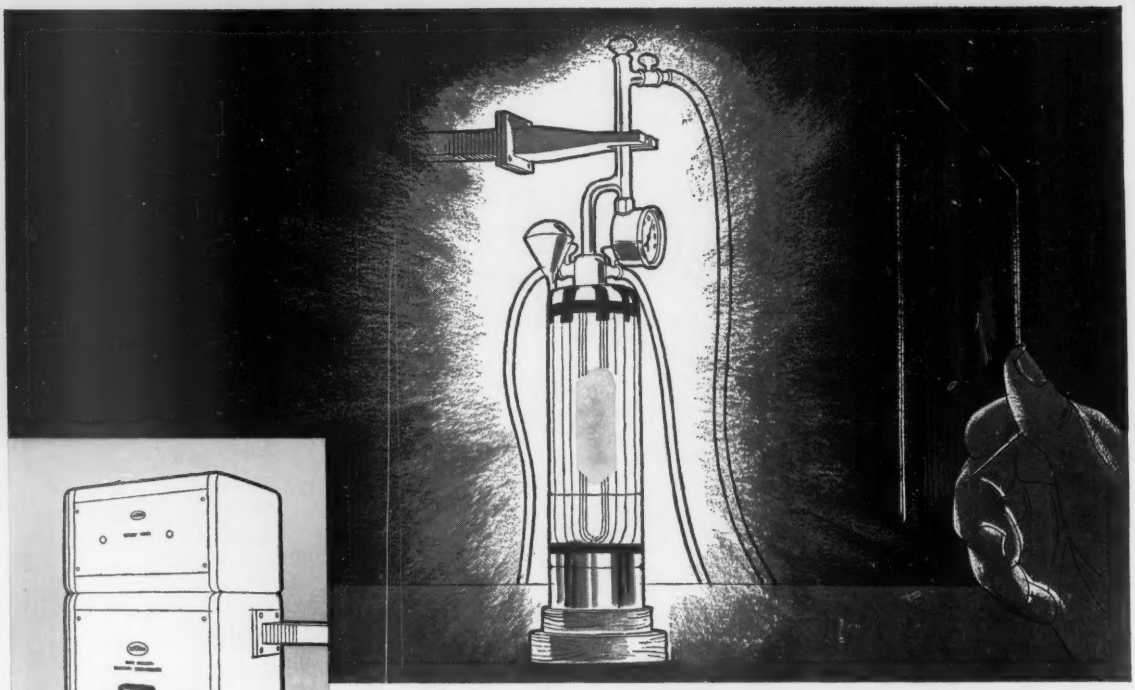
LAWRENCE ROSLER
Bell Telephone Laboratories, Murray Hill, New Jersey

The 12 Sept. 1958 issue of *Science* [**128**, 594 (1958)] contains an article entitled "A system of names for binary numbers." In the article the author runs these named binary numbers into one another, stating, for two such names: "the larger value . . . being named first signifying *addition*" and "the smaller value being named first signifying *multiplication*." This is all very well as long as only two such quantities are involved. What is not stated is the law relative to a string of three or more such named quantities, which the author actually uses in the table of examples.

Consider, for instance, hiapdag. This is, according to the rule stated, hi + ap × dag. The question is, however, does the addition precede the multiplication, or vice versa? In other words, does hi + ap × dag mean (hi + ap)dag or hi + (ap × dag)? It will be noted that these are different. One might assume that the latter is correct, since that interpretation alone will cause the first example, hiapdagcidone, to equal 297, as we are told is the case. But not so, for in the very next example bruonedag must mean (bru + one)(dag) in order for it to equal 87. Likewise, in the third example aponedag must mean (ap + one)(dag).

One might hope to find the clue in the author's statement, "numbers not specifically named are expressed as sums and products of the named values analogous to conventions used with the decimal system." In the decimal system the named digits have values dependent upon their position, and thereafter ad-

(*Continued on page 279*)



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Unidentified Seismic Events

Last summer a group of experts from East and West assembled at Geneva to determine what would have to be done to set up a system for detecting explosions of nuclear weapons. Two kinds of explosions offered special difficulties: those set off underground and those set off in space. For the detection of underground detonations, to which we shall confine our attention, the question to be answered is: are there detectable differences between artificial and naturally occurring earthquakes?

As it now turns out (see p. 259), the data available last summer—obtained from a single nuclear explosion and several TNT explosions—have proved to be inadequate. Ordinary earthquakes send out compression waves in some directions and waves of rarefaction in others. Consequently, some seismographs will pick up, as the first detectable motion, waves of one or the other types. An earthquake initiated by an underground explosion, on the other hand, sends out, as the first motion, compression waves only. All seismographs within range pick up the first motion as a compression wave. It is this characteristic difference that permits the identification of a shock as of artificial origin.

The results of the three test explosions carried out in late October, 1958, showed that the earlier tests had led to an overestimation of the energy of the waves generated by explosions. Hence, at more distant stations the possibility that the first identifying compression wave will be swamped by background tremors ("noise") is greater than was thought last summer. Thus the number of unidentified seismic events that might or might not be of human causation is severalfold more than had been estimated.

These new estimates do not mean that a control system is out of the question, but only that the system proposed last summer—a network of 180 seismic stations and a system of on-site inspection of suspicious events—may need modification. One important first step would be to augment the data. Perhaps the best way to do this would be, as Senator Pastore has recently suggested, to carry out additional tests under international sponsorship, a procedure which would give the participating nations confidence in the results.

Such an undertaking would not exhaust the possibilities. The seismic stations could be more closely spaced; inspections could be made of a larger number of unidentified seismic events; better instruments could be developed.

After the scientific questions are answered, the political questions will remain. When the probability of detection can be more closely estimated, the political negotiators will still have to decide whether that probability is sufficiently high to deter a potential violator. Absolute assurance that all explosions of small devices can be detected cannot, at least at present, be given. What can be given is an estimate that a certain percentage of all shots will be detected by a system of defined characteristics. Where that percentage may be safely set is a political decision of great difficulty and great importance. But it is a decision that can be reached if both sides sincerely want to reach it.—G.DuS.

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Man as an Object of Science

To what extent can the social sciences be expected to explain and help solve the problems of man?

Ernest van den Haag

The influence of science has mounted at a steadily accelerating rate over the last few centuries as scientists have annexed more and more realms to their dominion, and scientific methods are applied to almost all human activity. As it grew, science became self-conscious: an elaborate philosophy of science, a metascience, now analyzes the methods science uses as well as its scope, the meaning of its theories, and the kind and degree of certainty it can yield.

The self-consciousness of science was increased when scientific study was extended vigorously to human behavior itself, and the social sciences (including psychology) posed anew questions about the range and the effects of science which had lingered since its beginnings. These questions are of two types. The first is, can science deal with human beings as it can with the rest of nature? That is, is the behavior of people as predictable (and by analogous methods) as the behavior of other physical bodies and organisms? Are the social sciences, then, as scientific as, say, physics? (This question, of course, requires an answer, at least by implication, to the question: what makes science scientific?) The second type of question is, can the social sciences solve the problems besetting humanity in the same way in which chemistry solves a chemical problem? Or, what, precisely, is the potential role of the social sciences in the direction of human behavior, particularly in controlling the social changes which the progress of the natural sciences has made more necessary than ever?

The author is adjunct associate professor in the Division of General Education, New York University; lecturer in the department of sociology and anthropology, City College, New York; and lecturer in the New School, New York.

Objectivity

Just as the scientific purpose and method of the natural sciences were thought at first to be impious and immoral, so were those of the social sciences. With regard to the social sciences, however, this objection is still with us, though usually in disguised form.

As soon as political science was refounded in the Renaissance, moralists asked whether it is permissible to do what Machiavelli did—in Bacon's words, "to describe frankly and without dissimilation what men do, and not what they ought to do." (Actually, Machiavelli generalized too much from his specific surroundings; yet many of his observations remain applicable.) *The Prince* describes how power is achieved, held, and lost. This is what politics *qua* politics is about (whatever the ends for which power is desired or used), and, therefore, what political science must be concerned with. Yet the thought is still repugnant to many, as witness Machiavelli's reputation through the ages, and such truisms as "power politics," which are as sensible, Jacques Barzun rightly remarks, as "food nutrition" would be.

Machiavelli was particularly vulnerable to moral objections because his description of political behavior was cast into the prescriptive form of advice to a ruler. His critics thought he must approve of the prince's goal—power at any price—and of all the means for the achievement of this goal which he recommended as effective. Whether or not he did and, if so, for what ulterior reason, should be irrelevant to the political scientist. What matters to him is whether the means recommended are as effective as Machiavelli thought—whether he correctly observed the relation between cause and effect in politics.

Somewhat later, when economists studied how a man would have to act to maximize his income, the same question was raised: should men act that way? The misunderstanding of the nature of science on which such questions are based, far from being confined to outsiders, is shared by many social scientists. Yet, approval or disapproval of the behavior he studies is as irrelevant to the task of the economist as it is to the task of the political scientist. In this respect, social scientists do not differ from meteorologists, though people are usually more resigned about the weather than they are about themselves. Perhaps we can do more about human behavior (and we certainly feel more responsible for it) than about the weather. But we will succeed only if we first study it, without ignoring undesirable aspects and possibilities.

Nonetheless, there is one consideration to which not enough attention has been paid, and which might lend some force to the view that the study of social behavior cannot be quite neutral morally: such a study may have automatic effects, desirable or undesirable, apart from increasing our knowledge. Something analogous to the Heisenberg effect in physics may occur in the social sciences; the observation, the attendant requirements, and the publication of results may unavoidably influence that which is being observed (for better or for worse). So far this effect has been minor. But to the extent to which it does occur, it modifies the assumption of neutrality. Observation, to the extent to which it is likely to influence what is being observed, is

not neutral in its effects, and possibly it does not record what would have occurred had there been no observation. Social scientists have accorded but fitful recognition to this fact, perhaps because they do have a vested interest in recognizing it whenever the anticipated effects of their activity are beneficial, and in ignoring it otherwise.

Models

Uneasiness about the moral aspects of behavioral studies probably also prompts the questions about "economic man" which appear to be based on modern psychology: do men really act to maximize their income? and do they do so as rationally as economists assume? Actually, economists, in building a model of man as income maximizer, need not assert anything about the psychology or the nature of man, or even about his ordinary behavior; they need to explore only how a man would have to act, if (all other things being equal) he wanted to maximize his income. Nor does such a model assume anything about the rationality with which we actually pursue the fulfillment of our desires.

The economic model depicts the behavior that would be rational if a given end—income maximization—is assumed. But, in essence, economic calculation is simply rational calculation: how to achieve *any* goal with the least expenditure of whatever is to be economized. Hence, if we replace the goal of income with some other goal, or, better, add some other goals, economic analysis still needs to be applied. In this respect, economics may serve as a paradigm for all social sciences, as was pointed out by the political sociologist Gaetano Mosca.

The importance of the economic model in predicting human behavior (as distinguished from indicating the implications of assumed behavior) depends on the actual strength of the income-maximizing tendency and the influence of the excluded variables. This is so with any theoretical model: its relevance to reality depends on the importance of the included variables in reality; and models become models by excluding some variables, to concentrate on others.

The exclusion is not a defect or sin but a virtue—which becomes a vice only if the model builder is unaware of his exclusions or forgets about them, and attempts to apply conclusions drawn from the model directly to human behavior. This, of course, has happened often, but is no more reason for throwing out models in the social sciences than anywhere else. On the contrary, it is a good reason for constructing models which include the variables excluded before, whether separately or together. Sociology, anthropology, and other sciences are attempting, however haltingly, to do so.

Methodological Problems

It is possible to abandon the assumption of rational behavior altogether. We need retain only the assumption that we can find regularities of behavior—for without that assumption no study could bear fruit. But the assumption of rationality is useful inasmuch as it can guide our search for regularities and help make these regularities intelligible. Finally, if we wish to apply the social sciences to the control of human behavior, we have to postulate ends and calculate the most rational ways of attaining them. And to assume that people behave rationally is simply to assume that they have ends and strive to use suitable means to attain them—effective and economic means—means that are justified by the end (for nothing else can ever justify means, though, of course, no end can justify all means).

To say that people act rationally, then, is to make a judgment about how suitable the means used are to the ends pursued. Such a judgment requires us to know not only what people do, but also what they want to achieve. We will be misled if the true objective of the behavior studied is not what it is assumed to be. And much apparent irrationality may occur because people are vague or ambivalent about their objectives. Yet, not much would be gained if we were to drop the teleological model altogether in the social sciences. The real difficulties lie in empirically establishing regularities of human behavior, regardless of the form—purposive or not—in which they are described. And, as mentioned, the heuristic value of the teleological model is considerable. Above all, if we are to apply our knowledge of the regularities of human behavior for its control, we will have to investigate actual human ends anyway, and decide among possible ones.

Before we turn to the problems connected with application, some further problems of attaining knowledge about human behavior must be mentioned. Though not peculiar to the social sciences, these problems characterize them more than other disciplines. In studying individuals or societies, we deal with historical streams of events, which, unlike the models abstracted from them, take place in nonrecurrent situations. Wars, and economic depressions, and the institution of the family are classes of events which permit the classification signified by the words *war, depression,* and *family.* But, one war, one depression, one family, differs immensely from another, if only because each develops in unique historical circumstances. Strictly speaking, this is true as well for the events studied by the natural sciences. But in the natural sciences the most relevant features appear to be repetitive, whereas in the social sciences repetitiveness can be postulated only by abstracting from relevant and often decisive features, which, though not themselves unique, combine into unique situations. What is worse for the social sciences is that it is impossible to *reproduce* any of the situations that concern them. Because of this impossibility, we cannot actually isolate variables from one another so as to ascertain which are necessary and sufficient to produce the effects of which we suspect them to be the cause. We can do so only in our analytical models.

As for reality, we must rely on observation, without the basic advantage, offered by experiment, of keeping constant the actual environment of the phenomena under observation, and thus testing our hypotheses. The evidence for the theories of the social sciences is therefore unlikely to be ever as conclusive as the evidence for propositions in physics can be: the propositions of the social sciences are unlikely ever to be definitively tested. If a prediction which follows from a theory does not come true it may be that the theory is wrong. It may be as well that it would have come true were it not that some of the circumstances presumed to remain unchanged —*ceteris paribus*—did *not* remain unchanged. And we cannot ascertain empirically which was the case.

Moreover, for the sake of simplicity, we often must presume circumstances to remain constant which we know will actually change (though we do not know which way). Further, these circumstances are known to be relevant to what we study—for example, political developments are relevant to economic ones. Yet, the major attempts to create a uni-

fied social science—from Comte, to Marx, to Spengler or Toynbee—have proved to be without scientific value themselves, though they have served as sources for manifold inspirations, and are sometimes admirable as works of art or metaphysics.

Value Judgements

Even if the social sciences could predict with the degree of probability which characterizes the natural sciences, there are difficulties in applying such knowledge for purposes of control, which, though not altogether peculiar to them, are harder to overcome in the social sciences than in the natural ones. In physics, for instance, controlling energy means to utilize our knowledge so as to arrange matters in such a way as to produce the energy wanted. But in the social sciences we would have to arrange, not matters, but ourselves, so as to produce the desired result: we are not only the manipulators but also the manipulated. To some extent the natural sciences, when applied, also involve the manipulation of human beings, for instance in medicine. Uusually, however, the individual is free to take the physician's prescription or pour it down the drain. Moreover, people are fairly agreed on what they wish to achieve with the physician's help. In contrast, in the social sciences, the measures needed to change social phenomena require collective, rather than individual, acquiescence. And we are not agreed on what changes are worthwhile.

This last point is, perhaps, most serious. For the disagreement on what changes are worthwhile—on what ends we *should* strive for, individually and collectively—is not amenable to resolution by scientific means. Hence, to the extent to which social problems are rooted in divergent values, they are not likely to be solved by the social sciences. If collective decisions have to be taken, disagreements are not necessarily soluble, then, by any factual study such as science can undertake. (Actually this may be as true for individual decisions, if we regard the individual, not as a monolithic structure, but as composed of not necessarily integrated parts. There are then, perhaps, a number of equally possible and —in terms of the individual's values— equally successful bases for integration, and the decisions on the right one would not rest with the psychologist.)

This is not to say that the social sciences can be of no assistance. Divergent ends may be attained by different persons without conflict, and it is for scientific analysis to establish where this can or cannot be done. Further, ends may be pursued in ignorance of the means actually required to achieve them, or in ignorance of their unattainability or of their incompatibility with other ends simultaneously pursued. Knowledge of means and of effects may influence the ends people wish to pursue; and the social sciences yield such knowledge.

Some American philosophers even feel that most conflicts which appear to be about ultimate ends can be eliminated by increased knowledge. And some social scientists believe that a philosophical anthropology (or psychology) could establish the needs of human nature, and therewith the ends we should strive for. These views have the merit of calling attention to the fact that agreement on ultimate values is often greater than it appears to be, that many apparent conflicts about ends are due to ignorance of the precise implications of each end—the means needed and the effects achieved by it. Nonetheless, I think that those views are false if they are interpreted to assert that perfect knowledge would eliminate conflicts about values—about what is good, or right, about what should be done, about the ends that people should pursue in preference to others.

James Madison went too far when he wrote "if men were angels, no government would be necessary," if he meant that perfect knowledge, goodness and wisdom, such as may be attributed to angels, would lead to agreement on ends and means and thus make a government superfluous. Not so. If the angels do not all come from the same mold (and to assume that they do is to define away the problem and not to solve it), they may have different preferences. Some, for instance, may wish to leave nature unspoiled; others, in concrete circumstances, might want to give up some natural beauty in favor of, say, electric power or housing developments. No social sciences, indeed no knowledge at all, can decide which should be done, which is better, or even by what means the decision should be made; for the process by which the decision is to be made assumes criteria for decision making which ultimately must be based on values. Yet, decisions must be made all the time and we are not angels.

"Happiness" No Help

It is well known that Bentham's famous formula, which is still popularly accepted—the greatest happiness of the greatest number—is unfortunately of little help; the greatest happiness (if measurable at all) is not necessarily the happiness of the greatest number; which means that the greatest happiness possible may be achieved by enslavement of some to others. Bentham was a benevolent utilitarian. The Marquis de Sade, who fantasied just that, was a malevolent one; the premises are really the same; the ultimate values differ, but though one may prefer one set to the other, one cannot prove it right on the basis of the "felicific calculus" (or any other). Note how this kind of problem crops up in any decision made. Is the "happiness" of Southern Negroes or that of Southern whites, of Algerian *colons* or Arabs, to be preferred? Should local majorities or over-all majorities decide, or the interpretation of the will of a generation long dead?

On the other hand, the happiness of the greatest number when each counts equally, as Bentham intended, might be the least possible happiness in sum and surely less than the maximum one. All this is on the assumption that there is a homogeneous and measurable quantity called happiness. But that Benthamian assumption seems wrong for each person and, of course, interpersonally. The feelings that spring from eating a peach, defeating an enemy, reading a poem, smelling a flower, winning a gamble, making love, solving a problem, and so forth, cannot be quantified and added up so that after negative feelings are subtracted a net amount of happiness remains. Can one really say that a life replete with joys and sorrows yields the same net happiness as one that has little of either? Surely the quantities are not homogeneous enough to make even ordinal measurement meaningful.

Preferences can be observed; happiness is hard to observe, impossible to calculate. Anyone who thinks otherwise ought to read some of the great novels which describe man's career on earth. Yet we act—and must act—as though we knew what action will lead to a net increase of happiness. From the building of a highway to the imposition of a tax, such an assumption, though perhaps not causing the action, is used to justify it.

Finally, that happiness is desirable at the expense, possibly, of other things, is

to be shown, not to be assumed; and it cannot be shown by showing that it is desired. Moreover, unless we deprive "happiness" of meaning and assert that everything that is desired is desired because it is believed to lead to happiness—in which case we would not be helped much in choosing among desiderata, for we would be saying that we ought to strive for whatever we want to strive for—it seems that people do many things even though aware that they will not lead to happiness.

Finally, the social sciences have shown rather definitely that happiness as a goal for society is unhelpful for the simple reason that its contents are largely determined by society. In other words, what makes a group or individual happy is not, apparently, altogether dependent on biological or other inherent needs; it is decided largely by social conditioning. Inherent factors, at most, set a limit to the range of possibilities. Cultural conditioning influences individual personalities sufficiently to influence greatly, if not to decide, what will make them happy or unhappy. A native of New Guinea may be made happy by hunting heads successfully; an American, by making money; a medieval person, by becoming a martyr for his faith. Martial glory may make for happiness among some tribes; and peaceful, noncompetitive living, among others. If this is so, clearly it is meaningless to say that society should strive for the greatest happiness of its members. For, society in the first place appears to determine what the things (values) are that will make its members happy. In this decision—what social values shall we foster?—the rule "those conducive to happiness" (apart from all the other objections) is meaningless, for it is the choice of social values which determines what will be conducive to happiness.

Limits of Science

The social sciences can nonetheless assist in making social decisions. They can ascertain who wants what; they can ascertain what makes people want what they do want, and how their desires may be fulfilled, or changed. Such desires may arise from wrong beliefs—prejudices. If this is so, knowledge provided by science can change the desires. Unfortunately, the desire leads to the prejudice more often than conversely. And if this is so, the desire will not change with increased knowledge. On the contrary, though available, such knowledge is unlikely to be absorbed. Further, the desire itself—apart from its rationalization—cannot be proved to be right or wrong by any science. The one thing the social sciences cannot do—the one thing, indeed, no science can decide—is whether desires ought to be fulfilled or changed or frustrated.

If we could believe that people can pursue their aims independently, fewer social decisions would have to be made. But this is seldom so; worse, it is not at all certain that individual and group satisfaction do not require dissatisfaction of other individuals and groups. St. Thomas Aquinas might have been a good psychologist when he wrote that those who are in heaven will see the punishment inflicted on the damned "so that their ecstasy will be greatly heightened." Perhaps we ought to do without that ecstasy (though this "ought" cannot be proved to be "right"). But it might well be that such simpler things as the enjoyment of riches, of prestige, of power, are all predicated, not on having a certain quantity—which it might be possible to grant everyone—but on having more than others have, which obviously is something that cannot be granted to everybody. Surely that is the case with regard to prestige.

Even in simpler matters, valuation based on esthetic or moral decisions, and not on observation, is unavoidable, though the questions to be decided are largely framed by observation. Thus, economists may come to the conclusion that a certain degree of social mobility is required to achieve maximum social income. Sociologists, however, may conclude that the required degree of social mobility is detrimental to a person's relations with other people (and possibly with himself). In short, the social and the economic optimum may differ, and they may require inconsistent conditions. In analyzing the results of the industrial revolution, I have come to the conclusion that we bought economic advantages at a fairly high cultural and psychological price [see R. Ross and E. van den Haag, *The Fabric of Society* (Harcourt, Brace, New York, 1957), chap. 15]. Assuming that my analysis is correct, it fails to provide an answer to the question: was it worth our while? And, indeed, no scientific answer is possible to such a question, whether it regards irreversible past developments or the future.

If Not Science, What?

Are we then to despair? Not unless we assume that science is the only method of solving problems. And that assumption seems unwarranted, even though scientists often develop a faith in science which is no more justified by science than religious faith is. (Faith—belief in "the evidence of things not seen"—is far more justifiable in the religious than in the scientific context. Science is based on the evidence of things perceptible by all who are skilled. Not so religion, which admits divine grace, revelation, and providence not necessarily intelligible to the faithful.) To admit but scientific methods is to assume implicitly that the cosmos is so arranged that its total magnitude and contents cannot exceed the grasp of scientific method—that nothing can exist that cannot also be known intersubjectively and proved scientifically. Values, then, can be proved to be "right"—or the universe becomes valueless.

Yet this seems an unnecessary dilemma, explainable by the psychological impact of science, but in no way inherent in its methods or results. Only science can make *testable* predictions, and thus prove scientific theories. But, if it is correct to say that only what is true can be proved to be so, it does not follow that only what is proved, or provable, can be true. Demonstrability and truth are not the same. And there are many matters which pose problems that will not yield to scientific methods. To ignore such problems surely is not to solve them; to pretend that science can solve them is to create pseudoscientific morals and to discredit science. Philosophical reasoning is needed here. Such reasoning takes account of what science tells us about the facts of the situation, and about the probable effects of any move we might make. But philosophical reasoning goes beyond that by offering an analysis of moral premises, and of whether the various solutions are compatible with them. Such analysis will not prove the premises, and, therefore, will not prove the solutions to be correct or incorrect. But it can clarify what, precisely, is implied, and thus help us choose in full awareness of both the factual and the moral implication of our choice.

As for the "truth" of such moral implications of values, of ends and purposes of life, though science cannot establish it, one may well allow that there is such a truth—even though people disagree on where and how to find it. A difference of

beliefs does not imply that there is no truth or that it cannot be found. It implies only that it has not been found. The situation is not very different from the situation in art: it is probably impossible to prove that one composer is a great musician and another is not, that one novelist is a great writer, and another is not. Yet, I shall continue to hold very strong convictions on the value of their respective works; and I shall not regard them as matters of taste but of esthetic truth. Analogously, I hold moral values to be matters of moral truth. Science will help somewhat—it will clear the underbrush—but reason and faith cannot be dispensed with, if we wish to map a transcendent road.

Peaceful Uses of Atomic Energy

A British scientist summarizes the results of the second Geneva Conference of the United Nations.

John Cockcroft

I have been given the difficult task of surveying the work of this conference, and using the wealth of new information, to look once again into the crystal ball and try to predict the course of peaceful development of atomic energy in the world. If we take as a yardstick the rapid progress during the last three years, I am sure you will not expect me to claim any great clarity of vision beyond the next five years.

The three years since the previous conference have been notable for the coming into operation of the world's first large-scale nuclear power stations at Calder Hall, Shippingport, and recently in Siberia. This has been of great importance, since we have thereby begun to acquire practical operating experience of nuclear power. This has provided us with experience on the operating characteristics of such stations, and much new information about their technology is being obtained to supplement the earlier small-scale experiments in research reactors.

Power Reactor Experience

Our first impressions have been that these nuclear power stations have been docile and well-behaved. They can generate electricity for months on end until some minor fault develops. The most usual faults have been the faults of conventional components which require the normal amount of maintenance. There has been a surprisingly small number of defective fuel elements. Fuel elements rely on their sheathing to prevent corrosion of the fissile material by the coolant, which can then lead to leakage of radioactive fission products into the coolant stream. Therefore a very high degree of integrity of the fuel elements is required.

The operators have reported good experience over the first two years of operation, with failure rates of only three or four per year in 10,000 fuel elements. Reactors using metallic fuel expect to achieve a burn-up of at least 3000 megawatt days per ton, so that 1 ton of uranium will do the work of 10,000 tons of coal. Reactors using uranium oxide fuel expect over three times longer burn-up (10,000 megawatt days per ton), and indeed good irradiation stability of small samples has been reported up to 25,000 megawatt days per ton. Our experience of burn-up of *full-scale* fuel elements is now nearly halfway towards the target. Accelerated experience will be gained in the future by increasing the enrichment of the fuel. A continuing large technological effort will need to be devoted to these problems.

The nuclear power stations so far built in the world have been either dual-purpose power stations or demonstration power stations, and they would not be economical as commercial power stations. Nevertheless the experience of their operation has been invaluable in preparing the way for the next generation, which in most cases will be fully commercial nuclear power stations, with credits for plutonium based on its real value for civil purposes.

Three Types of Stations

Three main types of second-generation full-scale power stations have been described to us: first, the graphite-moderated, gas-cooled reactors; second, the pressurized and boiling-water reactors; and third, the heavy-water-moderated reactors. The capital costs per kilowatt of the first of the commercial nuclear power stations have been very much reduced below those of Calder Hall and Shippingport but are still over twice those of coal- or oil-fired stations. The papers presented to the conference show, however, that capital costs are likely to continue to fall appreciably during the next decade. The capital costs of U.K. nuclear power stations will fall a further 20 percent by 1962 as the output goes up from 300 to 500 megawatts, and a further fall of at least 10 percent, resulting from straightforward engineering developments and increase of output, is forecast in a U.K. paper.

The boiling-water-reactor power stations seem to be growing in favor as a result of the good performance of the reactor experiments. Because of their low system pressure and small size and comparative simplicity, they may achieve very low capital costs in the next five years.

Sir John Cockcroft is director of the United Kingdom Atomic Energy Research Establishment, Harwell. This article was presented as an evening lecture on 12 Sept. 1958 during the Second United Nations International Conference on the Peaceful Uses of Atomic Energy, Geneva, Switzerland, 1–13 Sept. 1958. It is reprinted from the November 1958 issue of *Atom*, the monthly information bulletin of the United Kingdom Atomic Energy Authority.

Fuel Costs

Fuel costs are the second important component of over-all costs and range from 20 to 40 percent of the unit cost, depending on whether natural uranium or near-natural uranium or more highly enriched fuel is used. The graphite-moderated and heavy-water-moderated reactors will have the lowest fuel costs. Nuclear fuel costs for gas-cooled, graphite-moderated reactors have been given to us as about 2 mills. The Canadians believe that for heavy-water reactors these costs can be brought down to 1 mill. Fuel costs for light-water-moderated reactors have been reported to be about 3 mills. These are to be compared with conventional fuel costs ranging from about 3.3 mills in low-fuel-cost areas in the U.S. to 8 mills in European countries using imported coal. So nuclear fuel costs should in all cases be lower than conventional fuel costs.

The over-all economy of nuclear power stations depends greatly on the capital charges, the load factor, and the fuel costs in a particular country. High load factors are essential to counteract the present high capital costs. A United Kingdom Electrical Authority lecturer has told us that the first group of nuclear power stations could run continuously if there were no technical reason preventing this. The economic forecasts have, however, adopted the conservative figure of a 75-percent load factor. On this assumption, the 500-megawatt power station to be completed in 1962 is expected to achieve parity with coal-fired stations in areas in Britain away from coal fields. On the basis of our experience so far, these power stations seem likely to achieve an appreciably higher load factor, while fuel costs are likely to fall as burn-up increases with the development of our technology and as uranium prices fall, so forecasts may be conservative.

Parity Dates

By the late 1960's, as the installed capacity of nuclear power stations grows, the available load factor will fall. By that time, however, this is likely to be more than compensated for by further reduction of capital costs of the order of 20 to 30 percent, resulting from higher temperatures of operation and higher ratings associated with a switch to ceramic fuels. Nuclear power costs in Britain are therefore expected to fall well below conventional costs by late 1960's.

The date of achieving parity will be later in countries such as the U.S. where hydroelectric and stations using low-cost coal or natural gas can generate power at 4 mills. We have been told that stations started in the U.S. in the late 1960's should achieve parity.

In Italy, the World Bank study for the Societa Elettronucleare Nazionale nuclear power station has shown that, with the assumed 14-percent capital charges, nuclear power would be about 10 percent more costly than power from oil, and that there is little economic difference between the various types. India has reported that the first 150-megawatt power station to be built in India could achieve parity. We see therefore that the date for achieving parity ranges from 1963 to 1973, depending on the circumstances of individual countries. This date will determine the rate at which large-scale installations of nuclear power stations will develop. The Organisation for European Economic Co-operation predicts that Western Europe will have an installed nuclear capacity of 10,000 megawatts by 1965. The U.S. has predicted 1300 megawatts by 1963; the U.S.S.R. 2000 megawatts by the early 1960's. All of this might add up to an installation of about 15,000 megawatts between 1965 and 1970.

There is general agreement that by 1975 most new high-output power stations will be nuclear.

Underdeveloped Countries

H. J. Bhabha, in his evening discourse, has dealt with the need for atomic energy in underdeveloped countries, taking as his definition countries where per capita income is low. Since India comes very low in the table of per capita income, it comes in this category. Indian power requirements are doubling every six or seven years, and Dr. Bhabha considers that nuclear power stations would be competitive now and may have an installed capacity of 500 megawatts by 1965. Japan seems to be in a similar situation and predicts 750 megawatts by 1965. The growth of nuclear power in other underdeveloped countries will depend on their indigenous fuel supplies and on the available loads, and on the state of technological development. It will be hard for nuclear power to compete with diesel power where power requirements are less than 30 megawatts, and load factors are low. It should be remembered that technicians are scarcer than graduates in many countries, and they are crucial to this development. I agree with our president [H. J. Bhabha] that nuclear power will not perform miracles in underdeveloped countries.

By the late 1960's new, third-generation types of stations may be coming into service. We have had reports of operational experience with their precursors, the reactor experiments. The organic-liquid-moderated reactor experiment has shown that this reactor is likely to be simple to operate because of its low system pressure and its noncorrosive, nonradioactive coolant. The previously unknown cost of replacement of the moderator required by radiation breakdown seems to be about 1 mill per kilowatt-hour. The Oak Ridge experience on the aqueous homogeneous reactor shows good progress in overcoming the difficult compatibility problems, but the stability of the fluid fuel is still a crucial point. The sodium-graphite reactor experiment will provide important information on sodium technology and on metallic fuel elements operating at high temperatures. The high-temperature, gas-cooled reactor projects, for which all-ceramic fuels are used, may well be important for propulsion as well as for land use by the end of the 1960's. A high-temperature, gas-cooled reactor experiment seems likely to be built in Britain as a collaborative European project.

Fuel Cycles

We have heard a number of interesting papers on fuel cycles. It seems clear that with the general trend to the use of uranium oxide fuels, most reactors built after 1965, with the possible exception of the heavy-water reactors, will require some enrichment. The graphite-moderated reactors will require only modest enrichment, of the order of 1 percent uranium-235. The light-water-moderated reactors will require enrichment ranging up to 3 percent uranium-235.

The enrichment can be provided either by using uranium-235 from diffusion plants or by using plutonium from earlier reactors. Thereafter the reactors could operate on a natural or slightly enriched uranium feed by recycling plutonium, using this in the form of oxide mixed with uranium oxide. We have heard of promising technological work on recycling and of the limitations imposed by the accumulation of higher isotopes such as plutonium-242. One of our speakers has pre-

dicted that by the time nuclear energy is producing 20 percent of world power we shall need to invest about 5 percent of the capital for nuclear power programs in diffusion plants to provide the initial charges of uranium of low enrichment.

An alternative fuel cycle involves feeding the plutonium to reactors of the fast breeder type; this will have a positive gain factor for plutonium. The advantage of this would be that, in the long term, we should achieve a much better utilization of world uranium supplies. The superabundance of uranium which is forecast for the next two decades has shown that this is not an urgent problem. We can therefore take time to develop the difficult technology of fast reactors in a thorough manner. We have heard reports at this conference on the results obtained with experimental fast reactors; from their operation we have gained a great deal of knowledge about the physics, kinetics, and stability of these reactors which has been important in the design of the higher power reactor experiments which will come into commission during the next two years. Already, however, prototype fast-reactor power stations of 50- to 200-megawatt electrical output are being constructed and designed. The rate of installation of fast reactors will depend, first, on our experience with the reactor experiments and second, on the rate at which plutonium becomes available from thermal reactors. Fast reactors are unlikely to contribute much to world power before the 1970's.

Thorium possesses considerable advantages as a fuel for thermal reactors, but a large investment of uranium-235 or plutonium is required to start the thorium cycle. We have had a description of the Indian Point 275-megawatt (electrical) nuclear power station, which will be the first full-scale reactor to use the thorium cycle. Thorium may well be coming into use by the late 1960's, especially since large supplies will be available as a by-product of uranium mining.

Uranium and Thorium Supplies

We have heard from Jesse Johnson that his 1955 forecasts of uranium and thorium supplies have been more than realized. He has told us that on the basis of current production costs we could obtain supplies of at least 40,000 tons a year of uranium oxide at prices of between $8 and $10 a pound. The ore reserves in South Africa, Canada, the United States, and France are likely to contain at least 2 million tons of uranium, and on the basis of present geological data and the experience of the last ten years, an additional 2 million tons is likely to be available. These forecasts are two to four times higher than those made in 1955. If we guess that reserves in the U.S.S.R., China, and other countries are of the same order, the world reserves of high-grade ore are likely to be of the order of 10 million tons of uranium. The supplies of uranium in lower concentrations in shales and phosphorites are said to be unlimited. We have also heard that in addition to deposits of thorium in India, important deposits of thorium have been found in Canada at Blind River, where the ore contains one part of thorium to two parts of uranium oxide. World thorium reserves seem likely to be at least 500,000 tons.

At the 30 percent burn-up which might be achieved by breeding, 10 million tons of uranium are equivalent to 10^{13} tons of coal; this is three times the world's estimated coal reserves. We are likely to have developed fusion power long before we run out of uranium.

Nuclear Propulsion of Shipping

The technical feasibility of the nuclear propulsion of shipping has been abundantly demonstrated by the voyages of the U.S. submarine *Nautilus,* culminating in the remarkable voyage underneath the polar icecap. The pressurized-water reactor used to develop steam for its propulsion has proved to be highly reliable. We have heard of the first approaches to commercial nuclear propulsion. The *N.S. Savannah,* a combined passenger-cargo ship coming into commission in 1960, will use a pressurized-water reactor developing 22,000 shaft horsepower. The pressurized-water propulsion unit seems likely to achieve fuel costs, based on U.S. prices, about equal to those for fuel oil. Present capital costs are, however, three to four times higher than conventional capital costs, and a drastic reduction of these costs is necessary before parity with conventional propulsion is achieved. The United States expects to build a nuclear tanker with a boiling-water reactor for propulsion by 1962. Since this type of reactor appears to have lower capital costs than the pressurized-water reactor, this should help to bridge the gap, though operating costs will still be well above conventional costs. It seems likely that we will have to wait five years or more before we will know whether truly commercial nuclear propulsion is a feasibility.

However, there is one immediate application which would be impossible without nuclear power. The opening up of the 6000-mile seaway north of Russia has had to wait for the practically unlimited endurance of the nuclear-propulsion unit, and we have heard details of the icebreaker "Lenin," which is due to be commissioned in 1959. Three pressurized water reactors will provide 44,000 shaft horsepower for propulsion.

In contrast to the hopeful outlook for marine applications, commercial nuclear aircraft propulsion seems much further away.

Fusion Reactors

In his presidential address to the last conference, H. J. Bhabha said he predicted that a method would be found for liberating nuclear fusion energy in a controlled manner within the next two decades. The papers presented to this conference on fusion research have shown that remarkable progress is being made in this field on a very broad front. Most workers have in view the long-term objective of attaining "temperatures" of 50 to 100 million degrees in a mixture of deuterium and tritium gas. This should make it possible to reach the "break-even point" at which the energy release from fusion reactions in a mixture of deuterium and tritium gas would equal the energy input. The long-term goal is to go well beyond the 100 million degrees—to use the deuteron-deuteron reaction and eliminate the dependence on lithium as a source material for tritium.

Although we have been using the word *temperature* as a measure of our progress, we should remember that it is not strictly applicable to these very complex hot plasmas. We have also to remember that the electron temperatures are often very different from the deuteron temperatures, and that it is the latter which are important for our objective.

We have had reports from several laboratories that "temperatures" up to several million degrees have already been achieved in deuterium gas, with prospects of going considerably beyond this in the future. It is necessary, of course, to be able to hold these high temperatures for a sufficiently long time for an appreciable proportion of the deuterium to be burnt. Thus, at a temperature of 50 million degrees in a deuterium-tritium

mixture and with gas densities of about 0.001 atmosphere, only 1 percent of the deuterium would be fused in 0.1 second.

The containment of this high-temperature gas depends in all cases on the use of magnetic fields, the so-called "magnetic bottle." The containment also depends on our being able to maintain this hot, tenuous plasma, generating and radiating energy at a great rate, in a stable configuration not subject to violent oscillations or eruptive processes leading to loss of energy.

Two Approaches

Two main lines of attack on the fusion reactor have been described to us. The first is the pinched high current discharge method, used in the ZETA and other tori, the Stellarator, and the straight discharge tubes. The stability of the plasma depends critically on the relation between the magnetic fields produced by the circulating current and the additional magnetic fields applied to produce containment and stability. In ZETA, containment is not well understood, and we do not yet know how far we will be able to maintain containment as energy input is increased. We have heard that other torus devices can lose large amounts of energy by runaway electrons escaping to the walls of the tube, and that the production of a quiescent plasma is the crucial problem.

In the torus devices the plasma is heated in various ways: by resistive heating, by shock-wave heating, or by radio-frequency methods. "Temperatures" have so far been measured by Doppler broadening of highly ionized impurity atoms or by even more indirect methods. It seems that deuteron temperatures of several millions of degrees may have been reached but that electron temperatures are much lower.

The second class of fusion device, known as the "mirror machine," also contains the plasma in a "magnetic bottle," but the plasma is heated in a different way. In the Pyrotron, the first of the mirror machines, the plasma has been heated by using pulsating magnetic fields acting like magnetic pistons—to compress the plasma—and electron temperatures of about 10 million degrees have been reported. In the Oak Ridge D.C.X. machine, a plasma is formed by passing intense beams of high-velocity molecular ions into a chamber where the molecules pass through a powerful carbon arc and are split up into neutral and charged hydrogen atoms. The neutral atoms leave the plasma, and the charged atoms are trapped in the magnetic bottle and form a hot plasma. The progress of this method will depend critically on producing several amperes of molecular ions and on keeping the loss of energy from the plasma low; the method will be watched with great interest. The U.S.S.R. OGRA machine which has just been completed will work on a similar principle, but the molecular ions are to be split up by impact with the atoms already there in the course of a long spiral path to and fro between the magnetic mirrors. These mirror machines also will depend for their success on being able to maintain a quiescent plasma.

Fusion Prospects

Fusion reactors will aim ultimately at developing several hundred megawatts per cubic meter of plasma, so they may not be very different in size from fission reactors. It is too early to judge the relative prospects of the different approaches to fusion power, demonstrated so well in the exhibition, so much depends on experiments still to be carried out. Although neutrons emitted after the fusion of deuterium nuclei have been observed from many of the devices, the deuterons responsible have so far been mainly speeded up by direct processes. No laboratory has so far claimed what have been called "true thermonuclear reactions," though we are probably not far away from this. However, I agree with L. A. Artsimovich that this is not the important question. The origin of the neutrons will become clear enough if we can increase the temperatures in our plasmas. The important question is whether we can maintain stability in our plasmas as we feed in more and more energy, and whether we can, in due course, reach the break-even point where the energy generated by fusion equals the energy input. Peter Thonemann thinks this may well take ten years, and that even if we are successful it is likely to be at least another ten years before we know whether an economical fusion power station is practicable. I agree with this. Edward Teller's time scale is even longer.

Biological Aspects of Radioactivity

It is not to be expected that there will be any revolutionary advance in the applications of radioactive isotopes in medicine and biology. The principles of tracer work are now well established, so that now we see merely an increasing application.

Biochemistry has been revolutionized by the availability of labeled components, and with each congress much work is reported on their use in studying the dynamics of chemical reactions. Reviews of the ways in which radioactive tracers have extended knowledge in important fields, such as protein synthesis, have been given at this meeting.

Much of the now-classical work in biochemistry has been carried out with carbon-14. At the first conference, in 1955, Glascock pointed out the even greater potential value of tritium. This is borne out in the present conference, where it has been demonstrated that when tritium has been incorporated into thymidine, a specific label can be built into the nucleoproteins of cell nuclei. Tritium, with its very low-energy beta-emission, allows very precise localization by the autoradiographic technique. Already this is providing direct evidence on cell nuclear processes which formerly were merely inferred from indirect considerations.

Clinical medicine benefits in the same way from the application of radioactive tracers to problems of diagnosis and the measurement of individual body functions. The physician is no longer limited to identification of what goes in and what is excreted; he can trace intermediary metabolism in vivo by direct counting or by sampling tissues or body fluids. A notable contribution in this conference is the increasing accent on the use of shorter-lived radioactive isotopes in order to reduce the radiological dose to the subject. Ingenious, too, is the application of cyclotron-produced oxygen-15 for investigation of malfunction of the lung. The isotope pill for diagnostic purposes predicted by Willard Libby has already been demonstrated in the exhibition.

Occupational Exposure

The biological implications of nuclear energy, however, extend far beyond the hospital. Ionizing radiation is becoming one of the features of many occupations. The effect of this on occupationally exposed individuals and on the population at large has led to a great deal of experimental work, as well as to much speculation. The biological effects may be manifested within the individual's life-time, or only in his progeny as genetic effects. The recent report of the United Nations

Committee on Atomic Radiation and the work of the International Council for Radiation Protection have now provided us with sound guidance which will enable us to protect the health both of the individual worker and of the general population. It is comforting to report that at this conference we have had evidence given to us that doses of radiation received occupationally in the large government-sponsored projects are, with very few exceptions, gratifyingly low. Furthermore, we have evidence for the first time that private industry can carry out commercial operations with equally good records of exposure of personnel. We note from the retrospective survey by Court Brown and Doll that there has been no significant shortening of life in individuals exposed to doses which must have been very much larger, in the early days of the British radiological profession, and that the only major problem for that group of radiologists was cancer of the skin in the earlier workers—a hazard which we are now confident of avoiding.

Nevertheless, from the experimental data we see that shortening of life can result in animals when substantial doses are given. The effects of radiation on the induction of leukemia and other malignant diseases is now becoming much better understood.

Genetic Effects

It is on the genetic aspects of the biological effects of radiation that this conference has broken new ground. Hitherto, the direct proportionality of gene mutation with dose of radiation has been accepted as a law which holds, irrespective of dose rate, down to the lowest accumulated dosees. W. Russell and L. B. Russell have here produced evidence for departure from linearity in the relation between mutation rate and dose for point mutations in the spermatogonia of male mice. Furthermore, they have shown that the mature egg cell of female mice is substantially less sensitive to the induction of mutations than the spermatogonia of the male. Similar results have just been reported by Carter from Harwell. These two facts will probably necessitate a complete reconsideration of the quantitative predictions of the genetic hazard.

Another gratifying feature of the genetic reports is the increasing effort devoted to study of irradiated populations. While characters determined by single genes are ideal objects of laboratory study, most of the mammalian characters of major importance—in a word, fitness—are the summation of effects of many genes. Studies of fitness of populations are thus of great significance but difficult to mount. Our lecturers are to be congratulated on initiating and carrying out such important work.

Health and Safety

A number of lecturers have discussed the problems of reactor safety. We have had reports on the important experimental work on the kinetics and stability of reactors. We have learned about the effects on reactor kinetics of the accumulation of radioxenon and the growth of plutonium in fuel. These will not produce any difficulties in operation provided the reactor instrumentation is adequate.

We have also learned a great deal from three reactor accidents which have led to partial melt-out of the reactor fuel elements. Although two of the reactors were put out of commission for a year and one was written off, no one was hurt by these accidents or received an overdose of radiation. The results of the accidents agree in a remarkable way with data presented in one of the experimental papers in showing that only a very small fraction of some of the bone-seeking isotopes escaped from the melted fuel. The disturbances due to these accidents were accordingly less than envisaged in the 1955 papers. Later generations of reactors than these early models are much better protracted by containment and instrumentation, and some papers have shown that considerable progress has been made in advanced designs of containment which are thought to be proof against the maximum credible accident. This gives us considerable reason to anticipate safe operations in the future, and we may, in due course, expect the location of plants in more populated areas.

National Organizations

We have also heard of the growth of national reactor safety and inspection organizations, analogous to those in being for the aircraft industry. They inspect designs and prescribe codes of operation to help to maintain safety. We may also need an international reactor safety panel to help smaller countries who do not have safety experts available to them.

In our legal sessions we heard that our international conventions may be required to deal with problems raised by mobile reactors, the disposal of radioactive effluents in the oceans, and any possible damages beyond national boundaries from reactor accidents.

Industrial and Research Uses of Isotopes

The multitudinous industrial uses of radioisotopes continue to increase rapidly. Libby has estimated that their use in process control, in the oil industry and other production fields, is already saving United States industry 400 million dollars a year and that the savings will soon reach the multibillion-dollar level. Topchiev has reported that the present annual savings to Soviet industry by their use amount to over a thousand million roubles. Several million meters of oil-well bores have been logged by neutron sources.

Sources of radiocobalt and of radiocesium are shortly becoming available in strengths of the order of 100,000 curies, for industrial applications. These powerful sources will be used for sterilization of hospital dressings, pharmaceutical products, and other materials where chemical sterilization is less attractive. They can be used to produce grafted polymers in which the properties of the original polymer are beneficially changed. Thus, Libby told us that a styrene-polyethylene film had been used to make an ion-exchange membrane which had much improved properties for purifying brackish water. Topchiev has reported the production of block polymers of polyethylene and polystyrene which have high strength and stability up to 250°C. Many more chemical applications are promising, and we are likely to make full use of the tens of millions of curies of radiocesium and radiocobalt which could become available as by-products of the power program.

The movement of silt in river estuaries and harbors is now being studied with the help of radioactive tracers in many parts of the world, following pioneering studies in the Thames estuary. Gold- and tritium-labeled water is being used to determine the flow of water in rivers, sewers, and underground strata. This may have important applications to the survey of water resources in underdeveloped areas, and for the control of irrigation in arid areas.

The polonium alpha-particle camera is an example of a new research tool which will make it possible to measure mass differences of 10^{13} and possibly 10^{15} grams

in microtome sections of biological material. These examples of the industrial and research uses of isotopes, taken almost at random from an enormous field, can do no more than illustrate their already great and growing importance.

Fundamental Research

We have been both entertained and instructed by our sessions on fundamental research. New giant accelerators have been described to us, and we have heard that the cosmic ray workers, flying large stacks of photographic emulsions in Comet proving trials, have been able to obtain an enormous amount of new data on the collision of protons ten thousand times more energetic than any which can be produced by the largest planned accelerators. We have also heard of the new discovery, by the orbiting satellites, of intense belts of 40-million-volt protons, 1000 kilometers or so above the earth in particular latitudes. The great question of why pions and nucleons exist, with their particular masses and particular interactions, remains totally unanswered, in spite of the wealth of new knowledge produced by the accelerators. Strange particles accumulate and now total 31. The theoreticians have a new occupation of inventing new rules and waiting to see whether the latest strange particle obeys them. Feynman has predicted that 20 years hence our successors may be convening a "Conference on the Peaceful Uses of Strange Particles."

New Tools

In the field of nuclear data we have heard that the present situation leaves no room for complacency, since present reactor technology requires much more precise information, which we shall have to work hard to obtain. To help in this, important new tools providing enormously powerful pulses of neutrons are becoming available.

In the chemical sessions we have heard of the isolation of weighable amounts of berkelium, and that the chemists look forward to going well beyond element 102, aided by expensive reactors with neutron fluxes up to 10^{16} per square centimeter per second, which they hope benevolent governments will supply in the future. The chemical effects of fission fragments appear to be much higher than anticipated, and this may have important technological consequences. There has been a rapid advance in solvent-extraction technology, and long-chain amines and long-chain derivatives of phosphoric acid have been synthesized, with highly specific activities. Such developments could have applications far outside the world of atomic energy.

We have had a rich feast—perhaps too rich—at this conference, not only from the lectures but from the exhibitions, which have enabled us to see in a few days, in an exciting visual way, work proceeding throughout the world. We have also held innumerable discussions in small groups to amplify the knowledge gained in our formal sessions. This is the classical method of cooperation in the scientific world. We will go away with a great deal to think about, and this conference, like the 1955 conference, is likely to have a profound effect on the future development of atomic energy.

Requirements for Growth of Single Human Cells

"Nonessential" amino acids, notably serine, are necessary and sufficient nutritional supplements.

Royce Z. Lockart, Jr., and Harry Eagle

A number of human cell strains serially propagated in monolayer culture have been shown to have the same nutritional requirements for growth (*1*). A minimal medium containing the essential 13 amino acids, eight vitamins, five ions, and glucose, supplemented with dialyzed serum, permitted the apparently indefinite propagation of all these cultures, with a generation time in the logarithmic phase of growth of approximately 20 to 24 hours. However, when cultures were initiated with a relatively small inoculum, and, in particular, when cloning was attempted with several cell lines by the method of Puck and Fisher (*2*), the cells failed to grow in the same minimal medium which permitted the growth of heavily seeded cultures. As is shown below, the additional factors required for the growth of these small inocula proved to be the "nonessential" amino acids, which, for the growth of heavily seeded cultures, need not be added to the medium; in many experiments serine alone sufficed.

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Methods

The present experiments (*3*) were carried out with four serially propagated human cell cultures: (i) the stock HeLa strain; (ii) the S3 HeLa clone isolated by Puck *et al.* (*4*); (iii) a human conjunctival culture (*5*); and (iv) the KB strain (*6*). The cultures were grown in suspension in "spinner" cultures, as described by McLimans *et al.* (*7*). With such suspension cultures, the only manipulation of the cells required in the preparation of the inoculum was that of dilution; this obviated the cellular damage incident to the dispersal of stationary monolayer cultures by Versene, trypsin, or mechanical means.

As suggested by McLimans *et al.* (*7*), the medium contained the essential amino acids and vitamins at twice, and phosphate at ten times, the usual concentrations, while calcium was omitted

in order to minimize cell clumping. The cultures were used in the logarithmic phase of growth, and cells were counted in a hemocytometer. In most experiments the number of cells per clump averaged between one and two. One hundred clumps, 50 to 83 percent of which were single cells, were plated in 5 milliliters of experimental medium in 60-millimeter Petri dishes, with three to five replicate cultures for each experimental mixture. The cultures were incubated at 37°C in a 5-percent CO_2 atmosphere, and the number of cell colonies was counted after 8 to 9 days' incubation. In some experiments, the rate of growth was determined by counting the number of cells per clone on days 2, 4, and 6.

Results

1) *The effect of dialyzed serum on plating efficiency and clonal growth rates of human cells.* The human cell lines tested in these experiments had a generation time of 20 to 24 hours in culture and could be kept in the log phase of growth indefinitely. The cells retained their capacity to adhere to glass surfaces and were able to initiate growth with no apparent lag. Similar results have been reported for the L strain and for monkey-kidney cells by Gwatkin *et al.* (*8*).

In heavily seeded cultures, human serum which had been dialyzed for 24 to 72 hours against running tap water, then dialyzed for 4 hours against distilled water, or against salt solution, was just as effective as whole serum. In cloning experiments, however, dialyzed serum was usually far less effective than whole serum in terms of both (i) the plating efficiency and (ii) the rate of clonal growth.

The plating efficiency with dialyzed serum was extremely variable. With some lots, 10-percent dialyzed serum was as effective as whole serum, but in other experiments it was wholly ineffective, in that only a few clones could be seen after 9 days (see Fig. 1). At serum concentrations of 1 to 5 percent, the plating efficiency with dialyzed serum was regularly lower than with whole serum tested at the same concentration, and in the same experiment (Table 1). This decreased plating efficiency in dialyzed serum was not due to the failure of the cells to adhere, but rather to the fact that many of the cells went through only a few generations and then stopped growing.

The clones which developed in dialyzed serum were consistently smaller than those observed in whole serum. As shown in Fig. 2, the smaller colony size in the dialyzed serum medium was usually referable to a decreased rate of growth and decreased with the concentration of dialyzed serum.

2) *The effect of nonessential amino acids on the growth of single cells in dialyzed serum media.* The addition of Tween-cholesterol (*9*) did not affect either the plating efficiency or the size of the clones obtained in dialyzed serum, and the addition of a number of cofactors (see *9*) was similarly ineffective. However, when the basal medium with dialyzed serum was supplemented with the seven nonessential amino acids (alanine, aspartic acid, asparagine, glycine, glutamic acid, proline, and serine), each at 0.1 to 0.2 m*M*, the plating efficiency and the clonal size (the latter reflecting the rate of growth) were equal to or in excess of those observed with medium containing the same amount of whole serum (see Table 1 and Fig. 1). Single HeLa, HeLa S3, conjunctiva, and KB cells could now regularly be cloned with a plating efficiency of 50 to 100 percent in 5 milliliters of medium supplemented with 2 to 5 percent dialyzed serum, and the rate of clonal growth was equal to that observed in a medium supplemented with 10 percent whole serum.

As shown in Table 1 and Fig. 1, serine was the most important of the seven "nonessential" amino acids which permit the growth of single cells in a minimal medium supplemented with dialyzed serum, and in most experiments serine alone was as effective as the complete mixture. The maximally effective concentration was on the order of 0.01m*M*. Glycine was regularly less active than serine. This probably reflects the relative inefficiency with which glycine is converted to serine in these cell cultures (*8a*).

Preliminary experiments indicate that the anomalous requirement by small inocula for ordinarily nonessential nutrilites is, at least in part, due to the loss of such nutrilites from the cell pool into the medium at a rate which may exceed the biosynthetic capacity of the cell. The possibility may also be considered that whole serum provides not only the preformed "nonessential" amino acids and compounds derived from them but growth factors which facilitate their biosynthesis or retention by the cell, and

Table 1. Data illustrating the reduced plating efficiency of human cells in a minimal growth medium supplemented with dialyzed serum and the effect of supplementation with "nonessential" amino acids.

Cell strain	Serum concentration in medium (%)	Plating efficiency* in basal medium supplemented with			
		Whole serum	Dialyzed serum		
			Alone	Plus 7 "nonessential" amino acids†	Plus serine
HeLa	5	16 ± 3‡	1.2	64 ± 7	48 ± 2
HeLa-S3	10	86 ± 7	0	96 ± 11	75 ± 10
HeLa-S3	5	83 ± 2	9 ± 1	79 ± 3	
HeLa-S3	2	34 ± 13	3 ± 2	65 ± 11	
HeLa-S3	1	0	0	23 ± 4	
HeLa-S3	0.5	0	0	0	
Conjunctiva	10	37 ± 4	8.7 ± 2	43 ± 4	35 ± 5
Conjunctiva	5	36 ± 2	2.0 ± 0.8	37 ± 5	26 ± 5
Conjunctiva	2	24 ± 2	0.8 ± 0.5	22 ± 0.2	20 ± 1
Conjunctiva	10	70 ± 22	89 ± 4		
Conjunctiva	5	88 ± 10	37 ± 6	84 ± 11	102 ± 5
Conjunctiva	2	38 ± 11	3 ± 3	38 ± 18	5 ± 2(!)
KB	10	45 ± 1	7 ± 2	40 ± 6	
KB	5	34 ± 5	5 ± 1	44 ± 6	43 ± 8
KB	2	20 ± 2	5 ± 1	32 ± 4	32 ± 2
KB	1	0	0.7	9 ± 5	19 ± 7
KB	0.5	0	0	4 ± 2	

* Percentage of cell clumps inoculated which grew out in 8 to 9 days to form visible clones containing more than 100 cells; smaller but viable clones were not counted. In most of the experiments the average number of cells per clump in the inoculum was less than 1.5, and 50 to 83 percent of the clumps inoculated were single cells.
† Alanine, asparagine, aspartic acid, glutamic acid, glycine, proline, and serine, each at 0.1 to 0.2m*M*.
‡ Average of 3 to 5 plates, plus or minus standard error (range of variation/number of plates).

which are lost on dialysis. The fact that in the present experiments, and contrary to the findings of Sato, Fisher, and Puck (*9*), neither added cholesterol nor cofactors were necessary for the growth of single cells in a dialyzed serum medium may perhaps be referable to the varying methods used for the preparation of the cell inoculum. In the present experiments, the inoculum was prepared by the dilution of cells growing in suspension. The physical and chemical changes produced by the dispersion of monolayer cultures with trypsin or Versene are thereby avoided.

Serine has here been shown to be required for the regular growth of single human cells deriving from serially propagated cultures. Neuman and McCoy (*10*) have recently shown that isolated Walker carcinosarcoma 256 cells, unlike heavily inoculated cultures, require either pyruvate, oxalacetate, or α-ketoglutarate for growth; and yet other compounds may be required for the clonal growth of other cell lines. It is possible that in the cultivation of mammalian cells directly from the animal host, specific metabolites may similarly be required which are not necessary for the propagation of already established cell lines.

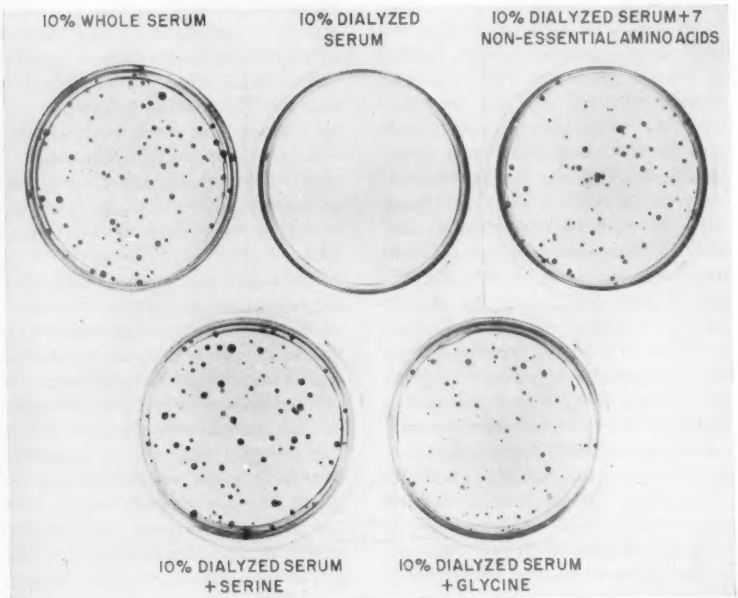

Fig. 1. The effect of "nonessential" amino acids on the plating efficiency of S3 HeLa cells in dialyzed serum. The seven nonessential acids included alanine, asparagine, aspartic acid, glutamic acid, glycine, proline, and serine, each at 0.1 to 0.2m*M*.

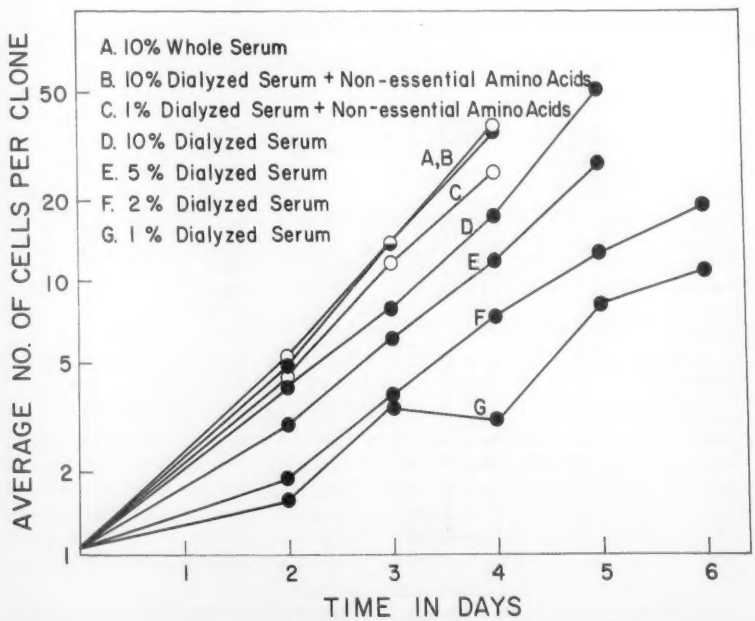

Fig. 2. The effect of "nonessential" amino acids on the clonal growth rate of HeLa S3. The seven nonessential acids included alanine, asparagine, aspartic acid, glutamic acid, glycine, proline, and serine, each at 0.1 to 0.2m*M*.

Summary

A minimal growth medium supplemented with dialyzed serum, which sufficed for the propagation of a wide variety of human cell strains in heavily inoculated monolayer and suspension cultures, did not permit the regular or optimal growth of small numbers of HeLa, HeLa S3, conjunctiva, or KB cells deriving from suspension cultures. At threshold concentrations of serum, the plating efficiency of single cells was greatly reduced as compared with their plating efficiency in a medium containing dialyzed serum instead of whole serum, and the clones which did develop grew at a slower rate. The nutritional deficiency could be overcome by adding the seven amino acids which are ordinarily not nutritionally essential. In most of the experiments serine alone sufficed.

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Charles F. Kettering, Prophet of Progress

"We are not at the end of our progress but at the beginning. We have but reached the shores of a great unexplored continent. We cannot turn back. . . . It is man's destiny to ponder on the riddle of existence and, as a by-product of his wonderment, to create a new life on this earth."

This is a characteristic saying of the late Charles F. Kettering, who always spoke with optimism about the future and who spent his life searching for new knowledge and developing new products. "We must use the past as a guidepost, not as a hitching post," he would say. "The only incurable diseases are those the doctor's don't know how to cure."

Charles Franklin Kettering was born on a farm near Loudonville, Ohio, 29 August 1876, the year of the Centennial Exhibition in Philadelphia. He went to the one-room country school and later, with an apple in his pocket, walked 3 miles back and forth each day to the high school in Loudonville. Then he became a country school teacher and Friday night debater. At age 22 he went to Ohio State University to study electrical engineering, but trouble with his eyes soon forced him out. In the two years following, he worked for the telephone company in the small city of Ashland, Ohio, during which time he not only learned to do everything in the operation of such a system but also made improvements in it.

In the fall of 1901 he returned to the university. Still saving his eyes, he did not study books as much as most students. He often lay on his back on the bed and listened to his classmates read the assignments. Later he joked that he could always tell how much studying he had done at night by how hoarse his roommate was in the morning. But it was luck, he said, that thus forced him to work things out in his head. It sharpened his imagination.

In 1904 he graduated from Ohio State at age 28 and took a job as experimental engineer at the National Cash Register Company. There, among other things he utilized electricity to take the tiresome handcrank off the cash register and developed one of the first accounting machines for banks.

After having invented a better ignition system for automobiles, he left the National Cash Register Company in 1909 and became an independent inventor and development engineer. With Edward A. Deeds he organized for that purpose the Dayton Engineering Laboratories Company which began its modest operations in what had been the hayloft of the Deeds barn.

Soon Kettering made that historic development, the electric self-starter for automobiles, which appeared first on the 1912 model Cadillac. The application of this development forced the Dayton Engineering Laboratories Company to become a manufacturing concern, much against the wishes of its organizers. And before long they were operating a factory employing 1,200 persons.

Nevertheless, Kettering found time to continue his experimentation. Soon he developed an engine-driven unit to furnish electric light and power on farms. This development and his prior work on battery ignition led him into another field in which he became the principal pioneer. This was the field of hydrocarbon fuels in which he made a long and productive effort to overcome their principal defect—the distressing bugbear of knock which limits the compression and therefore the power and efficiency of engines.

Charles F. Kettering

To work on that problem and others he organized a new laboratory in a second attempt to free his research from the hindrances in a manufacturing concern. World War I came just at that time, and out of wartime activities in that new laboratory came the first synthetic high-octane aviation gasoline and a manless automatic bombing plane which was the predecessor of the guided missile.

Soon after World War I, Kettering accepted an insistent invitation to organize and direct a central research laboratory for General Motors Corporation. He organized that laboratory around the small one he had set up just a few years before, and for the 27 years following he served as vice president and head of research for General Motors.

The developments which came out of his activities in those years were far too many to be enumerated here. But among them were the discovery of tetraethyl lead as an antiknock agent and of basic knowledge about the relationship of hydrocarbon structure to behavior in combustion, which together pointed the way to high-octane gasolines and high compression in engines; the development of better and longer-lasting finishes for automobiles; the discovery of the nontoxic and noninflammable fluorocarbons as refrigerants; the finding of means to take out of engines the old-time shake and shiver which were so distressing to automobile drivers and which cut down utility and durability; and the development of an improved diesel engine which, in one of its several applications, revolutionized the powering of railroads by superseding the century-old steam locomotive.

On his own account, through the Charles F. Kettering Foundation, he instituted and pursued a fundamental search for better ways to utilize the energy of sunshine. As he expressed it, he was trying to find out why the grass is green. "If we starve to death or run out of fuel, it's our own fault," he said. He spent many years, too, in search of

an answer to the question: What is magnetism? He wanted to find out, he said, just what kind of fingers a magnet has that lets it reach out and pull a piece of metal to it. Also, through research at Washington University and later at the Sloan-Kettering Institute for Cancer Research, he did what he could to aid in the search for ways to prevent and cure cancer. After he retired in 1947, he devoted most of his time to these three endeavors, doing much laboratory experimentation of his own on the first two.

One of the biggest contributions Kettering made to progress was as a vocal advocate of revitalizing changes in industry, not only in his own company but in others as well. In the early years of his activity the need for technological progress was not nearly so well accepted as it is today. "I am not pleading with you to make changes," he kept saying in his many public speeches. "I am telling you you have got to make them—not because I say so, but because old Father Time will take care of you if you don't change. Consequently, you need a procurement department for new ideas."

With Kettering, as with others consecrated to it, the search for new knowledge was a religion. C. P. Rhoads, director of the Sloan-Kettering Institute for Cancer Research, said this about Kettering's views of research, "His principal point is that if one is to have a productive career in research, one must have some well-defined objective. . . . Without objectives, he feels, scientific life is unsatisfactory and scientific work in general unproductive. This point of view is, of course, in sharp contrast to that so frequently enunciated in recent years by those who believe sincerely that there should be no objective in research." But Kettering believed that research not aimed at contributing in some way to human needs, however indirectly, is not justified.

Popular as a public speaker, Kettering made hundreds of addresses and radio speeches. These were full of the wit and wisdom characteristic of him. He had a knack of putting things in direct and simple terms, of using imagery and apt analogy, and of injecting anecdotes and humor to give his talks vividness and vigor. Many of his sayings and epigrams have been widely quoted. "The price of progress is trouble," he would say, "and I don't think the price is too high."

On education Kettering's views were not in complete accord with accepted beliefs. "If we drove an automobile the way we try to run civilization," he said, "I think we would face backwards, looking through the back window, admiring where we came from, and not caring where we are going. If you want a good life you must look to the future. . . . I think it is all right to have courses in history. But history is the 'gonest' thing in the world. . . . Let's keep history, but let's take a small part of the time and study where we are going. . . . We can do something about the unmade history."

Robert A. Millikan said of Kettering, "He is unique in that he combines in one individual the interest in pure science with the practical ability to apply knowledge in useful devices." Willis R. Whitney, too, said of him, "We have never had another man like him in America. He is the most willing man to do things I have ever seen. Benjamin Franklin was a little like him. Both had horse sense and love of fun. If a fellow goes to school long enough he gets frozen in his thinking. He is not free any more. But Ket has always been free."

In 1905 Kettering married Olive Williams, of whom he said that she was a perfect supplement to an absent-minded inventor. They had one son, Eugene W. Mrs. Kettering died in 1946, and afterwards Kettering said of her that she was the only possession of his he had never tried to improve.

Kettering was generous with his time outside his principal field. Among a multitude of activities were his services as president of the American Association for the Advancement of Science in 1945 and of the Society of Automotive Engineers in 1918, as chairman of the National Inventors Council from the time of its formation in 1940, and as a long-time director of the National Geographic Society. From his contemporaries he received numerous distinctions, including more than 30 honorary degrees and many medals and awards.

At the funeral of Kettering's associate, Thomas Midgley, Jr., the minister read the familiar Bible verse, "We brought nothing into this world, and it is certain we can carry nothing out." Afterwards Kettering commented, "It struck me then that in Midgley's case it would have seemed so appropriate to have added, 'But we can leave a lot behind for the good of the world.' "

That comment of his could apply with even more fitness to himself. For what he left behind, when on 25 November 1958 he quit this world at the age of 82, is a vast heritage to the people of the nation from a dynamic, many-sided, and highly creative life.

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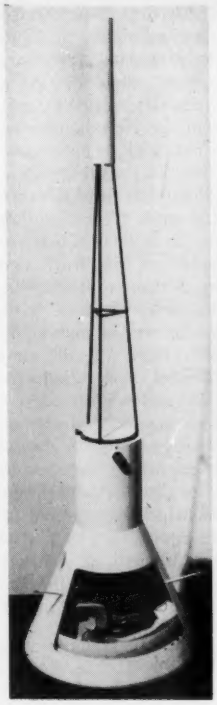
News of Science

National Aeronautics and Space Administration Has Outline for Manned Satellite Program

The National Aeronautics and Space Administration, the agency responsible for the country's nonmilitary space activities, has released some of the details of Project Mercury, its manned satellite program. Preliminary information on the launching and recovery techniques, the man-carrying capsule, and other details were given with the announcement that McDonnell Aircraft Corporation of St. Louis had been selected as the source for the final design, development, and construction of the capsule. McDonnell, founded in 1939, is currently producing the Voodoo and Demon fighters and is a subcontractor for the Talos missile program. The company's experience in designing and constructing jet aircraft cockpits will have direct application to the capsule design problem that Project Mercury poses.

Space Capsule

The man-carrying capsule, as now conceived, will be in the shape of a truncated cone with a short cylinder attached at the point of truncation. Less pedantically, it could be said to resemble a cathode-ray tube. The base diameter of the cone will be approximately 7 feet, with the other dimensions scaled accord-



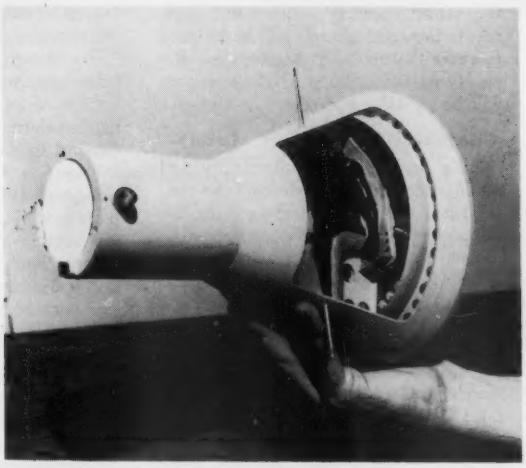


Fig. 1. (Left) Attitude and configuration of Project Mercury man-carrying capsule at time of firing. Capsule will be the payload of an intercontinental ballistic missile. Superstructure and top canister constitute escape system. Fig. 2. (Middle) Satellite showing orbital attitude and cut-away view of pilot and couch. Cylinder at left contains drogue and landing and reserve parachutes. Fig. 3. (Right) Reentry and recovery position. Landing parachute is not out and open in picture. Heat shield and retro-thrust rocket cluster are hidden by impact bag. Bag is one possible form for impact control. Final form will be determined by McDonnell-NASA Research.

ingly. (See Figs. 1 and 2.) A weight of about 1 ton is expected for the capsule, which may be made of nickel alloy or titanium. The satellite will have high aerodynamic drag, will be of the nonlifting type, and will be designed to withstand any known combination of acceleration, heat loads, and aerodynamic forces that might occur during boost or reentry. It will have an extremely blunt leading face covered with a heat shield, probably of beryllium.

Three antennas will project from the sides of the cone, and a port will be so placed as to allow direct observations by the occupant. Other devices will permit the pilot to see portions of the earth and sky.

Life support system. A couch, fitted into the capsule, will support the pilot during acceleration. The pressure, temperature, and composition of the atmosphere in the capsule will be maintained within allowable limits for human beings. Food and water will be provided; because of the short orbit time, 24 hours or less, problems of pilot maintenance are expected to be met by the techniques now used in jet fighter aircraft. Medical instrumentation, possibly including a television camera, will evaluate the pilot's response to space flight; data will be recorded in flight and telemetered to ground recorders.

Other instrumentation. Devices other than those directly concerned with the pilot's welfare will be a two-way voice radio, instruments to measure and monitor the internal and external capsule environment, and devices to make other scientific observations as space and weight limitations permit.

Control procedures and mechanism. A dual system of control procedures will allow for control of the capsule by the pilot, or the ground station, or both working in conjunction. The pilot will have the option of manual or automatic control during orbital flight. Small pitch, yaw, and roll jets will allow the pilot or the ground station to establish the proper attitude for orbit.

Launching

Project Mercury's man-carrying capsule will be thrust into orbit by an intercontinental ballistic missile. No specific information has been released on the vehicle and booster, but it can be assumed that the country's basic hardware, such as the Atlas, will be used with the modifications that will come up during the 2-to-3-year lead time that the project will require. Standard firing and phasing practices will be followed to take the missile's payload from the launching pad up to an orbiting altitude of roughly 100 to 150 statute miles. In the event of faulty ignition or improper lifting of the vehicle, however, an elaborate escape device will go into action.

Abort procedure. Projecting from the smaller end of the capsule will be a frame superstructure which will support a thin rocket canister. (See Fig. 1.) In a successful launching this device will have no function other than determining the center of gravity of the payload. In a faulty launching it will be the means whereby the pilot and capsule can be saved from destruction. If, during ignition and lifting, the ground crew becomes aware of any malfunction, it can initiate escape procedures by firing the rockets in the canister. These will lift the capsule up and away from the booster. Once clear of the carrier and at a sufficient altitude the superstructure and canister will be jettisoned, the parachute which would have been used in a normal reentry will be drawn out of the short cylinder attached to the cone, and the capsule will return to the surface where an impact bag will diminish the shock of landing.

Normal flight. If the launching succeeds, the satellite will separate from the carrier at the proper altitude, the escape-system superstructure and canister will be discarded, small reaction jets will shift the orientation of the long axis of the capsule from the vertical to the horizontal, and the satellite will go into orbit in the attitude shown in Fig. 2.

Reentry and Recovery

At any point during the capsule's flight, reentry and recovery techniques can be initiated by either the pilot or the ground-control personnel. In rough outline the procedure will be as follows.

By use of the reaction controls—the small jets placed around the capsule—the attitude of the container will be changed so that the firing of the retrothrust rockets at the base of the cone will start the capsule back toward the earth. The eventual impact area can be predetermined because of this control over the capsule's point of reentry into the atmosphere. As the capsule reenters the earth's atmosphere and slows to a speed approximately that of sound, a drogue parachute will open to stabilize the vehicle. At this time radar chaff will be released to pinpoint the capsule's location. When the velocity of the capsule decreases to a predetermined rate, a landing parachute will open. The parachute will open at an altitude high enough to permit a safe landing on land or water. The capsule will be buoyant and stable in water.

The nature of one element of the recovery system has not been definitely decided upon. This is the impact bag which appears as a large doughnut-shaped object in Fig. 3. Several approaches are being weighed by NASA personnel at the Langley Research Center, Langley Field, Va. One would have the impact bag an inflatable structure which would be tightly compressed under the heat shield during reentry and then expanded after the shield had been dropped and the parachute had opened. A second approach would have the impact bag made of a material similar to that which is used in air-dropping supplies and vehicles during air-borne operations. Such a material would have a very fine honeycomb structure to control the rate of collapse and thereby protect the capsule and pilot. Decision on this point, which will come of cooperation between NASA and McDonnell Aircraft Corporation, will determine the final configuration of the satellite.

As the manned capsule approaches the impact area it will be the focus of a variety of location and recovery procedures. By the fact that control will have been exercised over the timing of the reentry, ground equipment, presumably computers, and capsule equipment will be able to predict the general area of impact. To this information will be added the exact pinpointing allowed by the release of radar chaff—metallic tinsel of the type used for radio jamming. Triangulation on radio signals from the satellite will offer a supplemental means of location, as will visual observation if the reentry occurs during the daylight hours. Once the capsule is down, recovery aids such as tracking beacons, high-intensity flashing light systems, the two-way voice radio system, and, for water landings, sofar bombs (for sending underwater impulses) and dye markers will begin operation. In an operation of this nature, it can be assumed that ships, submarines, and aircraft will be assigned to cover the predicted impact area. Recovery of the capsule and its occupant will be virtually assured.

Responsibility for Project Mercury

In a project of the complexity and significance of Project Mercury the contributions of many federal agencies, the military services, and industry must be joined. Areas of responsibility for the many aspects of Project Mercury are as follows. Program management: National Aeronautics and Space Administration with the aid and assistance of the Department of Defense's Advanced Research Projects Agency. Technical direction: National Aeronautics and Space Administration. Capsule: McDonnell. Booster: industry. Launching and flight operations: National Aeronautics and Space Administration, military services, and industry. Supplemental research: government laboratories and industry. Crew selection, training, and in-flight evaluation: the aeromedical community.

Underground Nuclear Test Data

On 16 January the Department of Defense made public some details concerning the new seismic data on underground tests that have so affected the negotiations at the International Conference on Nuclear Test Control that is taking place in Geneva [*Science* **129**, 200 (23 Jan. 1959)]. The information released is that which was given to the Soviet and United Kingdom delegations at Geneva on 5 January, when the conference resumed after a Christmas recess.

Background

Since the conference of experts in Geneva reached its conclusions on 20 August 1958, the United States has conducted a series of underground nuclear explosions which were completed prior to 31 October 1958. There have been available to the conference of experts data on only one nuclear explosion—that of Rainier, 1.7 kilotons. In order to approximately augment the Rainier data for the purpose of more thoroughly understanding the problem of detection and identification of underground explosions, the yields of the recent underground tests were selected to fill in the range from 0.1 to about 20 kilotons. Each of the tests was extensively monitored with seismographs. As a result, data bearing on the detection and identification problems are now available.

While these new data are still undergoing evaluation by United States experts and only preliminary interpretations are at present available, the basic data and preliminary interpretations are felt to be sufficiently firm to permit derivation of certain conclusions.

To obtain the new data, temporary seismic stations were established at a number of locations along a line extending eastward from the Nevada Proving Ground to Arkansas and thence northeastward to Maine. The nearest station was about 100 kilometers from the shot points, while the most distant station was slightly more than 4000 kilometers distant. Each operating site was carefully selected by a team of geologists, who located suitable outcrops of hard rock remote from sources of man-made noise. Some 16 stations in all were equipped with Benioff short-period vertical seismographs and with auxiliary equipment for assuring proper interpretation of the recordings.

Seismographic recordings were made at these stations for the Blanca event on 30 October 1958, which had a yield of about 23 kilotons equivalent; for Logan on 16 October 1958, with a yield of about 5 kilotons equivalent; and for Tamalpais on 8 October, which had a yield of about 0.1 kiloton equivalent.

Conclusions

The following preliminary evaluation of the data obtained for these three events was given:

1) In the range of yields of 0.1 to 23 kilotons equivalent, the amplitude of the seismic wave varies approximately as the first power of the kiloton equivalent yield of the explosion.

2) The Blanca and Logan explosions produced artificial earthquakes equivalent in size to shocks of magnitude 4.8 and 4.4, respectively, on the Richter earthquake magnitude scale. The earlier estimate of the magnitude of the Rainier explosion was too high because it was based on a selection of data from a few stations which typically give larger-than-average amplitude. Consequently, the revised magnitude of Rainier is about 4.1, rather than 4.25 as previously estimated. It therefore appears that the previous estimate of the number of earthquakes per year equivalent to a given yield in kilotons requires revision upward.

3) The principal method recommended by the Geneva conference of experts for distinguishing earthquakes from explosions is of less utility than was thought prior to the three recent underground nuclear explosions—for example, the determination of the direction of first motion is much more difficult than had been anticipated at Geneva. It appears from the recent data that first motion is not usable as an identification characteristic of earthquakes that are equivalent to 20 kilotons or less when recorded at distances between 1100 and 2500 kilometers from the burst. At a distance of 200 kilometers the amplitude of first mo-

tion was less than one-third of the peak amplitude in the first pulse and at 1000 kilometers less than one-fifth. Consequently, it is now estimated that the first motion must exceed the background noise, or natural unrest of the earth, by at least a factor of 3 to 1 instead of the previous estimate of 2 to 1 if the direction of first motion is to be reliably determined.

Summary

The method for distinguishing earthquakes from explosion by direction of first motion is less effective than was previously estimated; the number of earthquakes equivalent to a given kiloton yield is about double the previous estimate. As a result of these two conclusions, the annual number of unidentifiable continental earthquakes equivalent to 5 kilotons or more will be greater than that previously estimated by the Geneva conference of experts by a factor of 10 or more.

Graphs and Recordings Provided

In addition to a report, the following graphs and copies of recordings were transmitted to the United Kingdom and U.S.S.R. delegations:

1) Copies of 36 seismographic recordings made of the three Hardtack II underground explosions.

2) A curve showing the response characteristics of the Benioff seismograph.

3) A table of estimates of Blanca, Logan, and Rainier magnitudes as estimated from various individual station recordings.

4) A curve showing the estimate, prior to and following Hardtack II, of the world's total number of earthquakes per year versus kiloton yield equivalent.

5) A curve showing the amplitude of the longitudinal waves as a function of the distance from the origin and also the amplitude of first motion as a function of the distance from the origin.

6) Curves showing the estimated total annual number of continental earthquakes as a function of kiloton yield equivalent.

Copies of these graphs and recordings are available for study. It is expected that the complete technical information will be made available to scientific journals in the near future.

The members of the panel that produced the conclusions presented were as follows: Carl Romney, U.S. Air Force, chairman; Billy G. Brooks, chief seismologist, The Geotechnical Corporation; Perry Byerly, director of the Seismographic Stations, University of California; Dean S. Carder, chief seismologist, U.S. Coast and Geodetic Survey; Frank Press, director, Seismological Laboratory, California Institute of Technology; Jack Oliver, professor of geophysics, Columbia University; James T. Wilson, chairman, department of geology, University of Michigan; Hans A. Bethe, Cornell University; D. T. Griggs, University of California, Los Angeles; Kenneth Street, University of California Radiation Laboratory; and Carson Mark, Los Alamos Scientific Laboratory.

East-West Scientific Exhibits

The United States and the All-Union Chamber of Commerce of the Soviet Union have reached agreement on the regulations and procedures to govern the exchange of national exhibitions of science, technology, and culture to take place next summer. The agreement, signed on 29 December, confirms earlier exchange agreements worked out in Moscow in October and November and in Washington in December.

The U.S. exhibit will occupy two buildings in Sokolniki Park in Moscow. The Soviet exhibit will be shown on two floors of the Coliseum in New York City for 4 weeks beginning 21 June.

This latest agreement makes the point that the success of the exchange of exhibitions requires "a substantial degree of flexibility and discretion" for each party to determine the scope, nature, and content of its exhibition as well as "a high degree of trust and cooperation." Further, each party may show "such motion pictures . . . as it deems appropriate which would be cultural and nonpolitical in character, devoted to an objective presentation of various aspects of its science, technology, or culture." Explanatory publications relating to the various displays may also be distributed by each party.

Rocket Development at Los Alamos

A method of propelling a rocket by a series of small nuclear explosions is being studied by a group of theoretical physicists and mathematicians at the University of California's Los Alamos (N.M.) Scientific Laboratory. This method was first outlined in 1947 by Stanislaw Ulam, research adviser at the laboratory and codeveloper of the hydrogen bomb. It was later taken up and extended by T. B. Taylor, former staff member at Los Alamos, who is now with General Atomic.

Studies at Los Alamos will determine how effectively blasts from explosions can be directed to get the maximum push on the rocket from given masses of exploding materials. Each explosion would give the rocket an extra push forward. Care has to be taken to avoid subjecting the rocket structure to excessively high pressures and temperatures, but Ulam believes this method might give several times more push for each pound of propellant than the reactor method.

If studies are successful, they will point the way to a possible method of propelling space ships through the solar system. In development of this concept, the laboratory will share ideas and information with the group at General Atomic, which has a contract to consider the possible structure and operation of such a space ship.

Science Information Council

The National Science Foundation has announced the appointment of scientists, leaders in the field of scientific documentation, and representatives of the public to the newly constituted 19-member Science Information Council. These members will serve with four ex-officio members as consultants to the foundation's Science Information Service, which was established in December [*Science* **128**, 1616 (26 Dec. 1958)].

The council will provide the Science Information Service with a broad range of technical skills and experience on problems in the dissemination of scientific information and the communication needs of scientists. The Science Information Service was set up to make scientific literature in all languages more readily available in order to shorten the time spent by scientists and engineers in searching for needed information. The service also seeks to bring about effective coordination of the various scientific information activities within the Federal Government and to improve cooperation between government and private scientific information programs.

Council members are as follows: William O. Baker, vice president of Bell Telephone Laboratories, Inc.; Graham P. DuShane, editor of *Science*; John M. Fogg, director of the Morris Arboretum, University of Pennsylvania; Elmer Hutchisson, director of the American Institute of Physics; Merritt L. Kastens, assistant director of the Stanford Research Institute; H. W. Russell, technical director of Battelle Memorial Institute; Verner W. Clapp, president of the Council on Library Resources, Inc.; E. J. Crane of Chemical Abstracts, Ohio State University; W. T. Knox, director of the Technical Information Division of Esso Research and Engineering; William N. Locke, head of the department of modern languages and director of libraries at Massachusetts Institute of Technology; John W. Mauchly, director of the Univac Applications Research Center of the Remington Rand Univac Division, Sperry Rand Corporation; Donald R. Swanson of the Infor-

mation Systems Division, Ramo-Wooldridge Corporation; Curtis G. Benjamin, president of McGraw-Hill Book Company, Inc.; Boyd Campbell, president of the Mississippi School Supply Company; John S. Millis, president of Western Reserve University; L. Quincy Mumford, the Librarian of Congress, Congress (ex-officio); Frank B. Rogers, director of the National Library of Medicine; Foster E. Mohrhardt, director of the library, U.S. Department of Agriculture (ex-officio); Burton W. Adkinson, head of the Science Information Service (ex-officio).

International Yard and Pound

Agreement has been reached between the national standards laboratories in British Commonwealth countries and the United States on international values for the yard and the pound, fundamental units in the British system of weights and measures. The following joint announcement was issued on 1 January.

"The directors of the following standards laboratories—Applied Physics Division, National Research Council, Ottawa, Canada; Dominion Physical Laboratory, Lower Hutt, New Zealand; National Bureau of Standards, Washington, United States; National Physical Laboratory, Teddington, United Kingdom; National Physical Research Laboratory, Pretoria, South Africa; National Standards Laboratory, Sydney, Australia—have discussed the existing differences between the values assigned to the yard and to the pound in different countries. To secure identical values for each of these units in precise measurements for science and technology, it has been agreed to adopt an international yard and an international pound having the following definition: the international yard equals 0.9144 metre; the international pound equals 0.45359237 kilogramme.

"It has also been agreed that, unless otherwise required, all nonmetric calibrations carried out by the above laboratories for science and technology on and after July 1, 1959, will be made in terms of the international units as defined above or their multiples or submultiples."

The international inch, derived from the international yard, is exactly equal to 25.4 millimeters. This value for the inch has been legally adopted by Canada. In addition, this value was approved by the American Standards Association for inch-millimeter conversion for industrial use in 1933 (ASA Standard B48.1-1933), was adopted by the National Advisory Committee for Aeronautics in 1952, and has been adopted by many standardizing organizations in other countries.

At present, for the calibration of line standards and end gages having nominal lengths expressed in inches, the National Bureau of Standards is using the inch defined by the Mendenhall order [T. C. Mendenhall, "Fundamental standards of length and mass," *U.S. Coast and Geodetic Survey Bull. No. 26* (1893)]. The values corresponding to this order are approximately

1 yd = 0.91440183 meter
1 in. = 25.4000508 millimeters

These are derived from the exact relation

1 yd = (3600/3937) meter

The inch used by the National Physical Laboratory of the United Kingdom for its calibrations is defined by the equation

1 in. = 25.399956 millimeters

It will be noted that the international inch is approximately 2 parts per million shorter than the inch presently used by the National Bureau of Standards and somewhat less than 2 parts per million longer than the inch now used by the National Physical Laboratory. To avoid possible confusion, during the transition period, National Bureau of Standards calibrations of length or mass expressed in English units will embody a statement indicating clearly the unit which has been used if the choice introduces a significant difference in the calibration values. Furthermore, if the accuracy of the calibration is such that the certified values would be the same in either international units or the older units, the qualifying adjective *International* will not be used—that is, the values will be expressed, for example, as so many inches or pounds.

The Coast and Geodetic Survey has requested the following exception, with which the National Bureau of Standards concurs.

"Any data expressed in feet, derived from and published as a result of geodetic surveys, shall tacitly bear the relationship: 1 foot equals (1200/3927) international meter. This relationship shall continue in being, for the purpose given herein, until such a time as it becomes desirable and expedient to readjust the basic geodetic survey networks in the United States, after which the ratio, as implied by the international yard, shall apply." This unit shall be referred to as the American Survey Foot. Inasmuch as there is little or no interchange of survey data, where the foot measurements are used, with industrial and scientific data, where the international units will be used, it is anticipated that no confusion will result from this dual usage. For example, base line surveys which might enter into a velocity of light determination would invariably be made in terms of meters.

The values of the pounds currently in use in the United States, United Kingdom, and Canada are as follows:

1 U.S. pound = 0.4535924277 kilogram
1 British pound = 0.453592338 kilogram
1 Canadian pound = 0.45359243 kilogram
1 International pound = 0.45359237 kilogram

The relative differences in the various pounds are substantially less than those in the yards, but since masses can be measured with greater accuracy than lengths, the differences can be significant. The present British pound is about 1 part in 10 million smaller than the international pound, whereas the U.S. and Canadian pounds are about 1.5 parts in 10 million larger.

The conversion factor for the international pound was selected so as to be exactly divisible by 7 to give the following value for the grain:

1 International grain = 0.06479891 gram

The grain is the common unit in avoirdupois, apothecary, and troy pounds. There are 7000 grains in the avoirdupois pound, and 5760 grains in both the apothecary and troy pounds.

The standard U.S. gallon and the Imperial gallon are so substantially different that a compromise international gallon was not practicable. The U.S. gallon is defined as equal to 231 cubic inches. On the other hand, the Imperial gallon is defined as the volume of 10 pounds of water under specified standard conditions. A fairly exact relationship is

1 Imperial gallon = 1.20094 U.S. gallons

Science in 1958

Year-end editorials have included a number on the significance of 1958 in the history of scientific development. The 4 January *New York Times* published the following.

The year 1958 "will go down as one of extraordinary scientific advance. The reason is that it saw the completion of the International Geophysical Year. . . . In this enterprise the U.S. and Russia sent satellites aloft with instruments to record space data. In addition, 30,000 scientists from sixty-six countries, manning more than 4,000 observation stations, amassed new knowledge of the earth, its crust, its oceans, its magnetic field, its belts of radiation, and the sun and space beyond.

"The satellite programs had military significance as part of the race for supremacy in missiles and space exploration. As 1958 began, the United States labored under the psychological burden of Russia's head start. Then came suc-

cesses. Three small United States satellites went into orbit. In May the Russians far overmatched them with the ton-and-a-half Sputnik III. But the United States followed with "lunar probes" that reached a quarter of the distance to the moon, and the first successful flight of an Atlas Intercontinental Ballistic Missile at full range of more than 6000 miles. In December a full Atlas rocket went into orbit—a feat comparable to the Russians' with Sputnik III. That Russia is still ahead, however, is apparent from their successful moon shot on 2 January."

News Briefs

The Atomic Energy Commission has contracted with the American Municipal Association to assemble and report on the available information relating to the impact of private atomic energy activities on local government. The contract cost of the study, which is to be completed in 6 months, is $14,860.

In authorizing the study, the commission noted that there has been growing interest and concern on the part of municipalities about the potential impact of private atomic energy activities on local governmental functions, services, and responsibilities, particularly with regard to public health and safety, fire protection, and zoning.

* * *

The National Aeronautics and Space Administration has established an Inventions and Contributions Board to evaluate scientific contributions to aeronautical and space technology. The board will recommend actions which would reward an inventor or contributor, or waive the government's title to inventions made in the performance of work under NASA contract. These decisions will apply to contributions by private citizens as well as NASA and other government employees, and NASA contractors. More than 250 proposals for aeronautical and space technology have been submitted to NASA since the National Aeronautics and Space Act of 1958 was passed last July.

* * *

Levels of strontium-90 in milk increased during September in eight out of ten sampling stations across the country, the Public Health Service reported recently. All samples remained well below the levels currently considered by the National Committee on Radiation Protection and Measurements to be permissible for consumption.

* * *

The second Holloman Summer Lecture Series, sponsored by the Air Force Missile Development Center, will be held 15–26 June in Cloudcroft, N.M. The lecturers will be Theodore von Kármán, Karl Pohlhausen, Paul S. Epstein, and Wallace D. Hayes, each widely known for his work in aerodynamics, physics, or applied mathematics. Housing information and other details may be obtained from Dr. J. R. Foote, P.O. Box 1053, Holloman AFB, N.M.

Grants, Fellowships, and Awards

Astronautics. The annual Daniel and Florence Guggenheim Fellowships for graduate study in astronautics, rockets, jet propulsion, and flight structures have been announced by the Daniel and Florence Guggenheim Foundation. From 18 to 20 fellowships will be given for study during 1959–60 at the Daniel and Florence Guggenheim Jet Propulsion Centers at Princeton University and California Institute of Technology and at the Daniel and Florence Guggenheim Institute of Flight Structures at Columbia University. The fellowships, of which six to eight are awarded for advanced study at each center and the institute, provide tuition and a stipend ranging from $1500 to $2000, depending on the stage of advancement of the student.

Fellowships are open to science or engineering students who are residents of the United States or Canada, who have outstanding technical ability and leadership qualities, and who intend to make a career in rockets, jet propulsion, flight structures, or astronautics. Applicants must file their credentials with the university selected *by 1 March.* Successful candidates will be notified by 1 April.

Biochemistry. The $1000 McCollum Award for Sustained Research in Biochemistry, made possible through the generosity of friends of Elmer V. McCollum, is to be awarded by the American Society of Biological Chemists at the spring meeting in Atlantic City, N.J. The award will be made to an investigator in this country who has continued to make significant experimental studies in biological chemistry after reaching the age of 60. In general, only those studies made since 1950 will be reviewed. Nominating letters and pertinent material must be sent *before 1 March* to Roger M. Herriott, 615 N. Wolfe St., Baltimore 5, Md.

Industrial Hygiene. Applications are invited for the Atomic Energy Commission's Special Fellowships in Industrial Hygiene, which lead to the master's degree in the subject. These fellowships are open to college graduates who hold bachelor's degrees in physics, chemistry, or engineering, and who are acceptable for graduate work at one of three universities to which they may be assigned. Fellows must also be under 35 years of age and citizens of the United States.

Basic stipend for industrial hygiene fellows is $2500 for the academic year, plus $350 for a spouse and $350 for each dependent child. Normal tuition and fees will be paid, as will a limited travel allowance. Applicants who have one or more years' graduate work or industrial experience in a related field may be eligible for an additional $200 in the basic stipend. Fellowship appointees study at Harvard University, the University of Cincinnati, or the University of Pittsburgh and, whenever possible, the applicant's choice of university will be adhered to. Applications, which must be returned *by 1 March,* are available from Dr. L. K. Akers, Industrial Hygiene Fellowship Office, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

Therapy. Each year the American Therapeutic Society presents the Oscar B. Hunter Memorial Award in honor of its late secretary, Oscar B. Hunter. The award is made in recognition of an outstanding contribution, or series of contributions, to therapy by an individual or a team of workers. One object in making the award is to bring recognition to those who have not received distinguished awards for their work. The term "therapy" is used in a broad sense to include the use of any drugs, procedure, or device of benefit in the treatment of patients.

The award consists of a bronze medal struck in the likeness of Dr. Hunter, mounted on a plaque, and engraved with the name of the recipient. The winner will be expected to deliver a paper that describes the award-winning work at the time of the presentation of the award. Travel expenses to the presentation will be furnished. Nomination letters, accompanied by a curriculum vitae of the candidate and a list of his publications, should be sent *before 1 March* to Dr. Harry E. Ungerleider, 393 7th Ave., New York 1, N.Y.

Scientists in the News

The National Science Foundation has announced the appointment of JAMES S. BETHEL as head of the Special Projects in Science Education Section, and ARTHUR S. ROE as head of the Course-Content Improvement Section. Both positions are in the Division of Scientific Personnel and Education.

Bethel is succeeding WALTER J. PETERSON, who will return to North Carolina State College as dean of the Graduate School. Bethel, on leave from North Carolina State, has held positions there of professor of wood technology, head of the wood products department, and acting dean of the Graduate School.

Roe is on leave from the University of North Carolina, where he has been Kenan professor since 1955 and chairman of the department of chemistry since 1952. He replaces DONALD B. ANDERSON, who has returned to his position as provost of the Consolidated University of North Carolina.

MICHAEL DARMADY, senior pathologist, Portsmouth, England, is spending the first 6 months of 1959 as a guest investigator in the Renal Research Unit, Research Department, CIBA Pharmaceutical Products Inc., Summit, N.J. The unit is directed by Jean Oliver and supported by the National Institutes of Health. In addition to his primary purpose of studying renal problems using the technique of microdissection, Darmady will survey sterile practices in American hospitals for the British Government.

Scientific visitors to the United States from the United Kingdom are as follows.

F. H. C. CRICK of the Medical Research Council's Molecular Biology Research Unit, Cavendish Laboratory, Cambridge, arrived in mid-January to take up an appointment as visiting professor in the chemistry department at Harvard University. He will spend approximately 6 weeks at the Virus Laboratory, Berkeley, Calif., before returning to the U.K.

D. S. ROBINSON, a member of the Medical Research Council's External Scientific Staff at the Sir William Dunn School of Pathology, Oxford, has been invited by L. W. Kinsell of the Institute for Metabolic Research, Highland Alameda County Hospital, Calif., to take part in a symposium on metabolic diseases, including atherosclerosis, that is to be held in San Francisco beginning 16 February. This will be followed by another meeting, "The Deuel Conference on Lipids," on the clearing reaction induced by heparin injection. He will also visit Cleveland; Chicago; San Francisco; Memphis; Nashville; Washington (3 March); Radnor, Pa.; and New York before he leaves the country on 7 March.

R. WHITTAM, member of the Medical Research Council's scientific staff at the Cell Metabolism Research Unit, Department of Biochemistry, The University, Oxford, has been invited by D. Nachmansohn of Columbia University to spend 6 months in his department as a visiting scientist.

Current Russian scientific visitors to the United States include ALLA MASEVICH, vice president of the Astronomical Council of the Soviet Academy of Sciences; IVAN ARTOBOLEVSKY, an engineer who is a specialist in automation; and ALEXANDER ALEXANDROVICH VISHNEVSKY, a specialist in cardiovascular surgery and a candidate for the Lenin Prize. Their tours are being made independently of one another under the auspices of the American Friends Service Committee, a Quaker organization that is sponsoring an exchange program of American and Russian scientists. During August and September, three American medical scientists visited the Soviet Union under the program.

HENRY A. IMUS, formerly assistant to the director, National Institute of Neurological Diseases and Blindness, National Institutes of Health, has joined the staff of the U.S. Naval School of Aviation Medicine, Pensacola, Fla. His position is supervisory psychologist, department of psychology, and head, Aviation Psychology Laboratory. He is responsible for the direction and coordination of research on problems related to the selection, training, assessment, and motivation of naval aviators.

At the recent meeting in Bloomington, Ill., of the American Society of Plant Taxonomists, two awards were given. The Cooley Award for the best paper on southeastern flora published during the calendar year 1957 was made to JAMES W. HARDIN ["A Revision of the American Hippocastanaceae," *Brittonia* **9**, 145, 173 (1957)]. The Cooley Award for the outstanding paper presented before a session of the American Society of Plant Taxonomists at Bloomington went to RICHARD A. HOWARD ("Vascular Anatomy of the Petiole as a Taxonomic Character"). The ASPT is able to make these awards through the generosity of one of its members, George R. Cooley.

S. W. HERWALD, manager of the Westinghouse Electric Corporation's air arm division at Baltimore, Md., has been elected the corporation's vice president in charge of research.

HAROLD P. KLUG has been appointed assistant director of research at the Mellon Institute, Pittsburgh, Pa. In his new position, Klug, who has been a staff fellow of the institute, will assist in building the investigational programs in physical chemistry, inorganic chemistry, and crystal physics.

ROBERT W. NOYES, gynecologist at the Stanford Medical School, has won the annual Squibb Prize of the Pacific Coast Fertility Society. He will present the prize-winning paper next April at meetings in Atlantic City of the American Society for the Study of Sterility. It is titled "Endocrine Control of the Passage of Spermatozoa and Ova through the Female Genital Tract."

Recent Deaths

HAROLD W. CLOSE, Princeton, N.J.; 70; dean of the School of Arts and Sciences of the American University of Beirut, Lebanon, from 1942 until his retirement in 1953; taught at the Beirut College for Women after his retirement; 2 Jan.

RICHARD H. DIEFFENBACH, Newark, N.J.; lung surgeon, who retired in 1956 after 50 years of practice; president of the medical staff of Clara Maass Hospital, 1937–51; headed the first clinic for tubercular cases in Newark; 3 Jan.

DONALD W. KNAGGS, Mount Vernon, N.Y.; 60; inventor of a method of printing on glass; 13 Dec.

CHARLES L. PARMENTER, Philadelphia, Pa.; 76; emeritus professor of zoology, University of Pennsylvania, since 1953; taught at the University of Southern California, the University of Wisconsin, and the University of Minnesota before joining Pennsylvania in 1916; 1 Jan.

WOLFGANG PAULI, Zurich, Switzerland; 58; physicist who received the Nobel Prize in 1945 for his work on the interrelationship of electrons; 15 Dec.

CHARLES S. REDDING, Philadelphia, Pa.; 75; chairman of the board of directors and former president of Leeds & Northrup Company; president of the Franklin Institute, 1941–46, and president of the Scientific Apparatus Makers of America, 1949–51; 2 Jan.

GEORGE L. ROBINSON, Chicago, Ill.; 95; theologian and archeologist who explored the Sinai Peninsula and discovered the sixth and seventh wells of Beersheba; director of the American School of Oriental Research in Jerusalem, 1913–14; 17 Dec.

EDWARD A. STRECKER, Philadelphia, Pa.; 72; professor and head of the department of psychiatry at the University of Pennsylvania from 1931 until his retirement in 1953; clinical professor of psychiatry and mental diseases at Yale University, 1926–32; professor of nervous and mental diseases at Jefferson Medical College, 1925–31; author of 200 papers and many books on psychiatry; 2 Jan.

VALENTINA P. WASSON, New York, N.Y.; 57; attending pediatrician at New York Infirmary, who wrote *The Chosen Baby*, a children's book on adoption; a specialist in mushrooms and coauthor of *Mushrooms, Russia and History*; 2 Jan.

HAROLD K. WILSON, State College, Pa.; 58; associate dean of admissions for research and development and professor of agronomy at Pennsylvania State University; formerly head of the department of agronomy; taught at Iowa State Teachers College and at the University of Minnesota; 31 Dec.

Book Reviews

Soviet Research in Catalysis. Chemistry collection No. 3. Consultants Bureau, New York, 1958. 7 vols. 1672 pp. $200.

This series of seven volumes has been compiled by the Consultant's Bureau from its translations of Russian articles on catalysis covering the period 1947 through 1955. The collection comprises 1672 pages (262 papers). All of the articles appear to have been taken from one or another of three Russian journals—the *Journal of Applied Chemistry (U.S.S.R.)*, the *Bulletin of the Academy of Sciences of the U.S.S.R.*, and the *Journal of General Chemistry (U.S.S.R.)*.

The seven volumes, for the most part, are restricted to heterogeneous catalysis; a few articles on homogeneous catalysis are also included. The subject matter extends all the way from basic theoretical papers on adsorption and catalysis through factual papers reporting experimental results and others giving interpretations and mechanisms. The topics covered are reduction, hydrogenation and dehydrogenation, Fischer-Tropsch synthesis, oxidation, dehydration, alkylation, isomerization, cracking, polymerization, Friedel-Crafts reactions, and Ziegler-type catalysts.

The quality of the articles ranges from excellent down to mediocre or poor. It is my impression that the quality is probably no better and no worse than that of a similar random selection from an eight-year collection of material on catalysis from the literature of other countries. There are, however, a few distinctly superior articles by workers who are respected throughout the world as leaders in their fields. Those interested in catalysis will welcome especially the English translations of such articles in the present series. Taken as a whole, the volumes constitute a very small sampling of the activities of those carrying on catalytic research in the Soviet Union over the period 1947 through 1955.

The individual volumes may be briefly summarized and characterized as follows.

Volume 1, *Theoretical and Sundry Associated Effects.* Fourteen of the papers cover the theory of adsorption and studies on the physical properties of porous catalysts. Included are two excellent papers by Volkenshtein giving a nonmathematical summary of the beautiful work that he has published under the general title of "Electronic Processes in Chemisorption." Other articles in this general category consider the flow of gases through porous beds, measurements of surface area and pore distributions, kinetics of catalytic reactions involving diffusion into capillaries of solids, adsorptive properties of charcoal, capillary condensation, and examination of catalyst surfaces during reaction by means of the electron microscope.

Nine of the papers refer to the reduction rate and phase characteristics of silicotungstates, alkali tungstates, and alkali molybdates. The remaining articles cover the use of carbon-14 as a tracer, phosphorescence, and the theory of chromatography in the liquid phase on heterogeneous surfaces.

Volume 2, *General.* This volume is well named inasmuch as it covers topics in almost every field of catalysis. About 10 percent of the papers refer to basic aspects of adsorption, catalyst structure, and surface studies on catalysts. These include an excellent paper by N. P. Keier on the use of isotopes in studying the distribution of active centers on nickel catalysts. Approximately 30 percent of the papers refer to the decomposition and dehydrogenation of alcohols over copper and chromium oxide catalysts and to the dehydrogenation of branched cyclohexanes over platinum supported on carbon. Fifteen percent of the papers are concerned with the decomposition of aromatic and cyclic compounds over silica-alumina and clay-cracking catalysts. The subject matter of the remaining papers is divided about equally among catalytic oxidation, dehydration, amination, condensation, and polymerization.

Volume 3, *General.* This volume is even more general than volume 2. No more than 10 percent of the papers refer to any one particular field. The contributions are about equally divided among mechanism studies involving the use of deuterium or oxygen-18; hydrogenation and dehydrogenation; cracking or rearrangements on clay and silica-alumina; adsorption and catalyst structure; amination reactions and reactions in liquid ammonia; oxidation; rearrangements over halide catalysts; polymerization and condensation; dehydration; and, finally, homogeneous catalytic reactions. One of the papers on the last-named subject was concerned with the accelerating effect produced by ethylene oxide on the thermal cracking of hydrocarbons; the other considered the mechanism of nitration catalyzed by mercury salts. In addition to these topics some of the papers presented miscellaneous special syntheses that can be carried out in the presence of solid catalysts.

Volume 4, *General, Reduction, Oxidation, Fischer-Tropsch.* Sixty percent of the papers in this volume are in the "General" category. They include discussion of the use of alumina-silica catalysts for the decomposition and transformation of various compounds containing sulfur and nitrogen; halogenation reactions and reactions catalyzed by BF_3; ketone synthesis from alcohols and acids; and amination reactions involving either ammonia or aniline as reactants. One of the more interesting papers is by Roginsky; it considers, from the standpoint of the electronic structure of solids, the catalytic decomposition of hydrogen peroxide on various oxides.

Two papers under the heading "Reductions" refer to reduction of hydrocarbons containing conjugated double bonds by sodium in liquid ammonia.

The eight papers on catalytic oxidation include a paper by Roginsky and his coworkers on the catalytic oxidation of olefins over silver and vanadium pentoxide. Five papers by Margolis seem to be basic oxidation papers; they include a detailed consideration of the additions of impurities or "modifiers" on the temperature coefficient, the kinetics, and the mechanisms of catalytic oxidation over standard partial oxidation catalysts.

Three of the Fischer-Tropsch papers cover the condensation of carbon monoxide with cyclohexene, methyl propene, propylene, or normal butene. These three papers are by one of the well-known experts in this field, Ya Y. Eidus. Unfortunately the catalysts used are given only by numbers. The remaining paper relates to some hydrocarbon synthesis studies in which alcohols were added in order to explore the part that they might play in the synthesis reactions over iron and cobalt.

Volume 5, *Hydrogenation, Dehydrogenation, Cracking.* The papers on hydrogenation and dehydrogenation are about equally divided among those relating to the mechanism and theory of catalytic hydrogenation or dehydrogenation and those containing factual results for particular systems subjected to either hydrogenation or dehydrogenation. About one-third of the papers contain discussions of hydrogenation or

dehydrogenation of aromatic or six-membered rings. Another large fraction includes a study of the catalytic hydrogenation of systems containing conjugated double bonds and systems in which the preferential hydrogenation of triple bonds with respect to the hydrogenation of other groups is of interest. Keier gives an excellent discussion of the adsorption centers on nickel catalysts for the hydrogenation of acetylene. Eidus contributes one of the few discussions that has been published on the mechanism of isosynthesis.

Only two of the ten papers on cracking cover what one might call basic work. Most of them give only factual accounts of catalytic cracking over silica-alumina, clay, or aluminum chloride catalysts.

Volume 6, *Isomerization, Alkylation, Dehydration.* The 20 papers on isomerization are about equally divided among factual papers and those which include both data and a discussion of possible mechanisms and theories. Reactants include the terpenes, paraffins, olefins, and five- and six-membered rings. Catalysts studied include silica gel, clays, chromia-alumina catalysts, $AlCl_3$, and titanic acid. One interesting reaction was the isomerization of 1,2-hexadiene into mono- and di-substituted acetylenes.

The alkylation reactions were concerned mostly with the alkylation of various aromatic compounds with olefins and alcohols. Several papers discuss the adding of alkyl groups to ammonia and other nitrogen-containing compounds. Magnesium oxide was especially active for these latter reactions. The other alkylation catalysts were rather standard ones; they included silica-alumina catalysts, phosphoric acid, BF_3 compounds, $AlCl_3$, and HSO_4-$AlCl_2$.

About one-half of the 11 papers on catalytic dehydration were by Y. A. Gorin and his colleagues and were concerned with the study of the Lebedev catalyst for converting alcohols into dienes having twice as many carbon atoms as the alcohols. Other dehydrations of alcohols and of formic acid were studied over typical catalysts, including silica gel, clay, alumina, and sulfuric acid. Several dehydrations in which gaseous H_2S and ammonia molecules help to effect dehydration were studied.

Volume 7, *Polymerization, Friedel-Crafts, Ziegler.* This is the shortest of all the volumes and contains three papers on polymerization, 16 on Friedel-Crafts reactions, and four that are classed under the title "Ziegler." The condensation of styrene oxide and ammonia over aluminum oxide, the dimerization of isobutene over quartz at low pressure, and the polymerization of oleic acid over BF_3 and phosphoric acid are the topics covered in the polymerization section. The Friedel-Crafts papers include four or five which deal exclusively with the mechanism of the action of aluminum chloride in such reactions. Other catalysts that are discussed include zinc chloride, antimony chloride, and ferric chloride. The four papers that are classed as "Ziegler" do not, in fact, contain any reference to the work of Ziegler. Two of them refer to the preparation of trichloroalkoxytitanes and trialkoxytitanium chloride. The other two are concerned, respectively, with the polymerization of styrene over ferric chloride and stannic chloride catalysts and the formation of various organoantimony compounds.

In conclusion, a few remarks should be made in regard to some of the important aspects of catalysis that are not included in this series. In no sense does this collection represent a treatise on the general subject of catalysis. Vast areas are completely omitted. For example, no mention is made of the catalytic synthesis of ammonia, the synthesis of methanol, the catalytic oxidation of ammonia, or the synthesis of higher alcohols. Furthermore, one of the most basic topics in the theory of catalysis, the influence of the electronic structure of solids on the catalytic activity, is hardly mentioned, in spite of the fact that this topic has been uppermost in the catalytic literature since about 1949.

It seems evident, in view of what has been said above, that the present series will be useful chiefly for reference to specific types of work that are treated in some detail and that it is not a comprehensive survey of the basic ideas of catalysis or their general application.

The books are paper-bound and rather fragile. The printing is satisfactory, but a few of the drawings and diagrams are a little difficult to read.

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Marine Ecology. Hilary B. Moore. Wiley, New York; Chapman and Hall, London, 1958. xi + 493 pp. Illus. $9.50.

Since the publication of James Johnstone's *Conditions of Life in the Sea* in 1908, there has been no single-volume exposition of marine ecology in English. Ecologists have nevertheless been busy these last 50 years, and a fantastically large literature has accumulated. It is a brave man who attempts to summarize this single-handedly, and Hilary Moore has in effect disarmed his critics in advance by pointing out that his book is a summary of his own specialized field in marine ecology, and by urging, in his concluding statement, other specialists to go and do likewise. Let us hope, then, that other publishers will not consider that this book has exhausted the field.

Moore is primarily an autecologist, and this book concerns the basic environmental factors of the sea and the natural histories of individual marine organisms. The opening sections deal with physical, chemical, and biological factors. These are followed by sections on the various marine habitats (including estuaries), and then there is a similar arrangement of sections on the organisms of the various habitats. A useful innovation is the classified list of genera, keyed to the index, which makes it possible for the reader to find the major classification of some 403 generic names without seeking them out in monographs.

Moore considers that only a very few basic principles of ecology have been established, and that an attempt to apply these to the sea would be to some extent misleading. Hence he does not discuss such matters as the theory of communities or of the ecosystem but addresses himself to "the needs of the student in the field." Some may feel that discussions of sampling techniques and statistics, or at least some indication of source material on these subjects, would enhance the use of the book for field workers. Others will feel that for formal instructional purposes it will be necessary to assign further readings on ecological theory in other works. The term *climax*, for example, is introduced without discussion.

In his fields of competence—the critical natural history of marine organisms and plankton—Moore has produced a book that will be widely useful, especially to workers who are not as familiar with the literature of northern Atlantic species and conditions (which constitutes the major part of the literature summarized) as they may be with that of their own regions. It is particularly useful to have the major aspects of the fisheries literature treated, since this is, after all, one of the principal branches of marine ecology. The sections dealing with intertidal and pelagic organisms are especially rich in illustrative examples, and throughout the book there is a nice balance between discussion of the complexities of interrelationships and simplification by examples, but that on coral reefs, like all such short treatments, does not do the subject justice. Chemical factors are treated rather skimpily, but adequate summaries may be found elsewhere (as the author indicates). The chemical cycles of the sea, to which Johnstone devoted some attention in his pioneer work, are not considered in detail here—another indication, perhaps, of how much more complex marine ecology has become in the past 50 years. As it is, there is a surprising amount of information in this comparatively short book, and all workers in marine biology will find it in-

dispensable, whatever they may think of it as an *ecology* text.

There are some 26 pages of references and a 35-page index. There seems to be an unnecessarily large number of typographical errors, especially in proper names; this should be taken care of in the next printing.

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Environmental Sanitation. Joseph A. Salvato, Jr. Wiley, New York; Chapman and Hall, London, 1958. xiii + 660 pp. Illus. $12.

This new text is the first, to my knowledge, that comprehensively treats the sanitation problems associated with the satellite communities that are flourishing in the rapid expansion of the suburbs. In his preface, the author acknowledges that many excellent texts are available which present the theory of sanitation practice appropriately for classroom and reference use. Most of these stress applications common to cities and towns with more than 5000 population. Others, under the general heading of "rural sanitation," lay stress on the individual farm household. First-hand experience with the activities and administration of sanitation services at the local-health-department level have added strength to the organization and content of this text.

An important aspect of this publication is the effort that is made to cover the everyday problems of the sanitary engineer and the sanitarian that arise in the course of their dealings with local government units. Such features include guidance on filling out forms for reporting on disease outbreaks, procedures for cement-grouting in the protection of wells, form letters on the design of private sewerage systems, check lists for inspection of food establishments, suggestions on how to serve as an expert witness during enforcement procedures, and information in a wide variety of administrative mechanisms.

A rather broad coverage of communicable diseases occupies the first chapter; this is followed by a brief presentation on steps to be taken in planning a facility. The remainder of the text is about equally distributed among seven chapters, covering water supply; sewage and waste treatment and disposal; swimming pools and bathing beaches; food; insects, rodents, and noxious weeds; housing; and environmental sanitation administration. The four appendixes present definitions of terms used in the text, excerpts from the "Public Health Service Drinking Water Standards" (1946), regulations relating to bottled water (California), and a most helpful grouping of miscellaneous data on weights, measures, computation of power requirements, and fluid flow and cost comparisons.

Generous use of illustrations, graphs, and charts adds to the utility of the presentation. Examples of design computations provide a ready guide to the proper use of formulae and design data. The generous number of footnotes for bibliographic reference will be of aid in more intensive study of specific items.

It is surprising that there is only passing reference throughout the text to the problems of radiation protection. As with most first editions of such a text, there are also some lesser errors of omission that will require supplementation when the book is used in teaching. An example is the reference to the advantages of positive-displacement pumps without any notation of the need for pressure-relief valves to protect such systems from excessive pressures. These defects are minor, however, and the author is to be complimented for undertaking to bring together so much material that many of us had to learn by the trial-and-error method.

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The Effects of Radiation on Materials. J. J. Harwood, Henry H. Hausner, J. G. Morse, W. G. Rauch, Eds. Reinhold, New York; Chapman and Hall, London, 1958. v + 355 pp. Illus. $10.50.

In March 1957 a colloquium on "The Effects of Radiation on Materials" was held at Johns Hopkins University, in Baltimore; sponsors were the Office of Naval Research and the Martin Company. This book is a compilation of the talks delivered at the conference, plus an extensive bibliography (nearly 800 references) concerning the effects of irradiation on solids and liquids.

It seems that the organizers of the conference have been rather successful in their aim to bring together a number of contributions which appeal to such different groups as physicists, chemists, engineers, manufacturers of structural components, and students of nuclear engineering. This does not mean that the collection is particularly homogeneous; it is obvious that bridges between the different areas of interest still have to be built.

The standard introductory article by Dienes presents the necessary theoretical background on different kinds of defects, number of displaced atoms, threshold energy, and so forth, and compares the theory with some experimental data. J. C. Wilson discusses radiation sources and experimental techniques, with emphasis on reactor facilities. The extent to which corrosion and surface properties of metals and alloys can be affected by radiation is discussed by M. T. Simnad.

Irradiation effects in different classes of solids are surveyed in three chapters, on metals and alloys (Billington), dielectrics (Smoluchowski), and semiconductors (Fan). The last two papers show clearly that an understanding of the mechanism of radiation damage in a particular material can be obtained only as a result of extensive research on the behavior of defects in such a substance (for example, alkali halides and germanium).

These papers are followed by two contributions devoted somewhat more specifically to engineering. C. E. Weber deals with the behavior and performance of core components (for example, fuel elements), while G. R. Hennig discusses radiation effects on a variety of reactor materials, including liquid and solid moderators.

The final chapters are devoted to organic substances. The status of radiation chemistry of organic compounds is reviewed by M. Burton; radiation effects on polymers and graft copolymerization induced by radiation are discussed by A. Charlesby and by A. J. Restaino, respectively.

To sum up, this collection of papers gives a reasonable picture of our present knowledge (and ignorance) in the rapidly moving field of radiation. One might hope, however, that in the near future a single author will muster the courage to review this field from a central point of view.

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Current Concepts of Positive Mental Health. Joint Commission on Mental Illness and Health, Monograph Series, No. 1. Marie Jahoda. Basic Books, New York, 1958. xxii + 136 pp. $2.75.

The first monograph resulting from the three years of intensive investigation and research of the ambitious Joint Commission on Mental Illness and Health is a noteworthy publication for two reasons. It contains as clear and authoritative a discussion of the nature of mental health as we are likely to get for several years. It also discloses the wide divergence in points of view of many psychiatrists and physicians, who think of mental health as absence of disease, and of a smaller

group of psychiatrists and many members of other disciplines, who consider mental health a combination of various constructive qualities.

Jahoda is a proponent of the idea that mental health is not synonymous with the absence of mental illness and that it is not the equivalent of normality. Instead she views it as a positive quality, to be approached in any one person by considering attitudes of the individual toward himself, the degree to which he realizes his potentialities through action, unification of function in the individual's personality, the degree of independence of social influences which he has achieved, the manner in which he sees the world around him, and his ability to take life as it comes and master it. A person may be mentally healthy in some ways but not in others.

Walter Barton, in a dissent from the views expressed by Jahoda, looks upon mental health and mental illness as a continuum, with illness as the point of departure and health as the goal. He believes that efforts devoted to improvement of total mental health in the community should be concentrated on preventing or treating major and minor mental illness.

No single definition of mental health can be satisfactory to all workers, nor is such a definition necessary for effective action.

This book is required reading for all who are seriously interested in improving mental health. It sets a high standard—one which it is hoped the nine subsequent monographs of the commission can maintain.

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General Cytochemical Methods. vol. 1. J. F. Danielli, Ed. Academic Press, New York, 1958. xi + 471 pp. Illus. $12.80.

The first of a proposed biennial series, this volume deals with some of the methods applicable to *in situ* characterization of subcellular structures. The nine chapters give varied treatment to the editor's outline calling for presentation of theory, instrumentation and procedure, critique of the method, illustrative results, appendices, and references. The topics covered are as follows: "Weighing of cellular structures by ultrasoft x-rays," by A. Engström and B. Lindström; "Determination of mass and concentration by microscope interferometry," by H. G. Davies; "Ultraviolet microspectrophotometry," by P. M. B. Walker; "Quantitative determination of DNA in cells by Feulgen microspectrophotometry," by C. Leuchtenberger; "Autoradiography as a cytochemical method," by S. R. Pelc; "Cytochemical demonstration and measurement of sulfhydryl groups by azo-aryl mercaptide coupling," by H. S. Bennett and R. M. Watts; "Indigogenic staining methods for esterases," by S. J. Holt; "Fluorescent antibody methods," by A. H. Coons; and "Calcium phosphate precipitation method for alkaline phosphatase," by J. F. Danielli.

All of these topics have been reviewed elsewhere at fairly regular intervals. The present volume is well written throughout by outstanding contributors and aims at rounded presentations. Most of the text originated at King's College, London, and in it the emphasis is primarily on physical instrumentation. Prior reviews are carefully indicated. Unifying accounts supplementing the existing literature are given, and there are fresh approaches to theoretical aspects.

Davies' chapter on the interference microscope is the longest in the book (107 pages) and an important major reference. Walker, in his article on ultraviolet microspectrophotometry, describes newer objectives, testing procedures for equipment, and errors due to the biological specimen, and he comments on items of apparatus in 11 short appendices. Pelc's presentation ignores Fitzgerald's earlier review and deals primarily with C_{14} and S_{35}. Both Coons and Holt include convenient appendices on synthetic procedures for their reagents. Leuchtenberger gives operational details for her particular instruments. The principal expositions of theory pertain to the physical instruments described by Engström and Lindström, who emphasize procedures for dealing with systematic errors in relation to x-ray wavelength. All the authors give brief reviews of recent applications of the methods to biological material.

In a succinct review of that hardy perennial commonly known as the Gomori method, Danielli calls attention to the application of interferometry to the estimation of alkaline phosphatase. It is unfortunate that a definitive review of a technique which has been examined "more critically than any other cytochemical technique" should not have avoided the elementary interpretive pitfall contained in the statement, "The amount of phosphatase present in a cellular site varies with . . . [the] substrate used."

Cytochemical methodology furnishes a good field for examination of the popular thesis that the value of a scientific method is dependent on its ease of application and the generality of its adoption by investigators. Referring to the vast preponderance of literature in visual microphotometry over that in the ultraviolet, Walker states that it "may not be a disadvantage since those who have been prepared to surmount the greater technical difficulties might be expected to be well aware of the difficulties of interpretation and of the many other hazards of inaccuracy." On the chemical side Bennett notes that his "mercury orange cytochemical method has not enjoyed the popularity which has fallen to the Barrnett-Seligman method in spite of the lack of specificity which the latter method can display." It is evident throughout that the methods which require the greatest appreciation of theory of instrumentation have generated the least controversy and also have been least widely adopted. On the other hand the widely adopted tinctorial methods have generated some classic polemics, often in inverse proportion to the degree of mathematical formulation required for interpretation.

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Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

The North American Species of Hesperus Fauvel, with Descriptions of Two New Species (Coleoptera; Staphylinidae). Transactions, vol. XII, No. 18. Ian Moore. San Diego Society of Natural History, San Diego, Calif., 1958. 8 pp.

The Marine Molluscan Fauna of Guadalupe Island, Mexico. Transactions, vol. XII, No. 19. 12 pp. *A New Mollusk from San Felipe, Baja California.* Transactions, vol. XII, No. 20. 2 pp. E. P. Chace. San Diego Society of Natural History, San Diego, Calif., 1958.

The Customs and Religion of the Ch'iang. Misc. Coll., vol. 135, No. 1. David Crockett Graham. Smithsonian Institution, Washington, D.C., 1958. 110 pp.

Making the Most of Your Years. Pamphlet No. 276. Evelyn Hart. 28 pp. $0.25. *What's in the Air?* Pamphlet No. 275. Hazel Holly. 20 pp. $0.25. Public Affairs Committee, New York, 22 E. 38 St., New York, 1958.

International Medical Research. A compilation of background materials. Prepared for the Committee on Government Operations, U.S. Senate, and its Subcommittee on Reorganization and International Organizations. 85th Congress, 2nd Session. Superintendent of Documents, GPO, Washington, D.C., 117 pp. $0.45.

Science and History. An inaugural lecture delivered at University College, London, 22 May 1958. Douglas McKie. Lewis, London, 1958. 17 pp. 2s. 6d.

Aviation Medicine. An annotated bibliography. vol. 2. 1953 literature. Arnold J. Jacobius *et al.* Aero Medical Assoc. 2642 University Ave., St. Paul, Minn., 1959. 360 pp. $5.

Photochemical Secondary Reactions in Urban Air. Rept. 24. Philip A. Leighton and William A. Perkins. Air Pollution Foundation, San Marino, Calif., 1958. 214 pp. $6.

Reports

Coturnix Quail as a Laboratory Research Animal

Abstract. The *Coturnix* quail is recommended to interested investigators, especially to embryologists and physiologists, for use in research because of its hardiness, ease of handling, precociousness, and great laying ability.

Many investigators in embryology and physiology prefer working with birds because of the accessibility of the embryos, the relative lack of expense and the short breeding cycles. One of the main drawbacks is the difficulty in getting confined birds, other than poultry, to reproduce at an economical rate, if at all. Therefore, we call the attention of interested investigators to the value of the *Coturnix* quail, *Coturnix coturnix japonica* Temminck and Schlegel (*1*) as a laboratory research animal.

This bird is an ideal laboratory animal for workers in the fields of avian embryology and physiology, especially endocrinology. It is extremely hardy, is easy to raise, reproduces at 6 weeks of age, and is very prolific. The *Coturnix* does not seem to be susceptible to any of the common diseases of the bobwhite quail.

The *Coturnix* was introduced into this country from Japan by the Missouri Conservation Commission (*2*) in order to determine whether it could become established ecologically and thus become a supplement to other game-bird species. Several states have subsequently been propagating and releasing the bird. To date, however, there is little evidence that the *Coturnix* has been established as a wild-game species.

Coturnix quails for research purposes can be obtained from some state conservation and wildlife agencies. The birds may be subject to individual state game regulations in accordance with the state laws.

Development of the young *Coturnix* is extremely rapid. The birds more than triple their size and weight during the first week after hatching. The first flight feathers are evident at 3 days of age, and strong flight is possible at 2 weeks. The birds are sexually mature at 6 weeks of age; a few lay as early as 38 days. Fertility is low at first, but by 50 days of age the fertility may be as high as 90 percent.

Sexes are easily recognizable at 3 weeks of age, and with practice reliable determination of sex can be made at 2 weeks. The females have a gray-and-black speckled breast, whereas the males have an even-colored brown breast with only a few speckles.

Interesting and extreme variations occur in the eggs, which may be snow-white, flesh-colored, dark or light brown, blue speckled to blue-violet, or brown mottled with a combination of all these colors. The size variation of the eggs is great; the length ranges from 20 to 35 mm. The eggs are quite large for the size of the adult bird.

The incubation period for the eggs in an incubator at 100°F is 16 days ±8 hours. Incubator temperatures of 103°F or above are harmful, and hatchability at these temperatures is low. Humidity should be kept at 60 to 70 percent, and the eggs should be turned at 8-hour intervals throughout incubation. Humidity should be raised to about 95 percent on the 15th day for highest hatchability. The hatchability, based on the number of fertile eggs, is about 60 to 70 percent under these artificial incubation conditions. However, we have found the eggs to be so plentiful that hatchability above 60 percent is usually not necessary for routine laboratory purposes.

For embryological studies, incubation should be timed from approximately 3 hours after the eggs are placed in the incubator, in order to allow them to reach incubator temperature. Eggs may be held as long as 2 weeks at 25°C before incubation without apparent loss of viability.

The young chicks are allowed to dry partially before being taken out of the hatching incubator. Next they are placed in a brooder with a coarse flooring to prevent their feet from slipping from under them. After 2 weeks in the brooder they are ready to be placed in the larger outdoor pens.

Breeder cages should be made of ½-in. mesh hardware cloth. A cage of 3 by 6 by 1.5 ft is suitable for housing 20 birds. The ratio of 5 males to 15 females will give 90-percent egg fertility. An excess number of males may lead to severe pecking. Although the top of the cage may be made of hardware cloth, a burlap covering is more suitable, since the birds are excitable and will scalp themselves against the wire top if they are disturbed. One end of the cage is provided with a protective wooden covering to provide shelter for the birds against extreme weather conditions. Freezing temperatures will not harm adult birds, but it is advisable to place a heat lamp at one end of the cage during extreme conditions. The outdoor pens must be protected by a fence, since cats, dogs, and other predators may disturb the birds and upset the laying schedule.

We used the following feeding regimen of Purina feeds with excellent results: From hatching to 2 weeks, the chicks were fed Game Bird Startena; after 2 weeks Game Bird Growena was added to the Startena in increasing amounts until, at 4 weeks, a 100-percent Growena ration was used. Growena was fed from 4 through 8 weeks, and after 8 weeks Game Bird Layena was used. Finely crushed oyster shells were added to the Layena to prevent the occurrence of soft-shelled eggs.

Food and fresh water were available at all times. Scratch feeds, such as cracked corn, should be used in the winter to provide extra carbohydrate. The *Coturnix* evidently has an extremely high rate of metabolism, as can be seen from the large intake of food and water, the great amount of droppings, and the high rate of egg laying.

The normal breeding season for the *Coturnix* starts in April and continues through September. During April and September the birds may become extremely restless, especially at night. This restlessness is apparently caused by a natural migratory instinct (*3*). Scalping against the top of the cage is greatest at this time.

The minimum amount of light per day required for egg laying is approximately 13½ hours. The game farm of the Alabama Department of Conservation at Prattville uses constant, 24-hour lighting in an indoor unit and obtains eggs throughout the year (*4*). Even under the most adverse conditions of pecking and scalping, the females continue to lay normally. During molting periods, laying will be greatly reduced.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

Many phases of the biology of the *Coturnix* have not been investigated. The bird's response to various types of light stimuli needs to be studied. Hormonal studies conducted on the *Coturnix* would be of great interest. At present, research is being conducted in our laboratory on the normal embryology and the gonadal development of these birds.

A study of anomalies occurring in the embryos and of the genetic and environmental factors affecting them would be of interest. We have found a number of cases of incomplete twinning. These twins, with one head and two bodies, have been found to be alive in the eggs as late as the 13th day of incubation. Several cases of perocephaly, such as have been recorded for the chick by Landauer (*5*), have been found, including cases where the cranium completely failed to form over the cerebrum.

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References and Notes

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19 August 1958

Hypoxanthine in Rosy and Maroon-like Mutants of Drosophila melanogaster

Hadorn and Schwink (*1, 2*), in an examination of the pleiotropic effects of the rosy^2 (*ry*^{2}; location, 3: 51 ±) mutant of *Drosophila melanogaster,* demonstrated that the mutant is deficient in isoxanthopterin and contains an excessive quantity of 2-amino-4-hydroxypteridine. At the same time, Forrest, Glassman, and Mitchell (*3*) observed that the maroon-like (*ma-l*; location, 1: near *beadex*) mutant of *Drosophila melanogaster* is deficient in an enzyme capable of catalyzing the oxidation of 2-amino-4-hydroxypteridine to isoxanthopterin.

Subsequent work has provided quantitative data on pteridine concentrations in the *ry* mutants (*4*), evidence that both the *ry* and *ma-l* mutants are deficient in the pteridine-oxidizing enzyme (*5*), and evidence that the enzyme involved is xanthine dehydrogenase (*5*). As indicated elsewhere (*5, 6*), this enzyme deficiency should lead to an accumulation of hypoxanthine as well as 2-amino-4-hydroxypteridine. This expectation has been found to be correct by observations of chromatograms from the mutants and wild-type *Drosophila* and by the isolation and identification of hypoxanthine from extracts of *ry*^{2} adult flies. It has also been observed that hypoxanthine rather than uric acid is a major nitrogenous excretion product of the mutant flies.

Table 1. Absorbing compounds in mutants and wild-type *Drosophila melanogaster*. The presence or absence of substances corresponding to hypoxanthine and uric acid was consistent in all five solvents. Approximately 5 percent of maximum quantities would have been detected by the methods used.

Extract	Uric acid position	Hypoxanthine position
Wild (Oregon)	+	−
ry^1	−	+
ry^2	−	+
ma-l	−	+

Chromatograms of squashed animals (*7*) or boiled extracts, and of known purines as controls, were developed in the following solvents: (i) *n*-propanol (2 parts): 1 percent aqueous NH_3 (1 part); (ii) isopropanol (3 parts): 1*M* formic acid (1 part); (iii) *n*-propanol (3 parts): 2*N* HCl (1 part); (iv) isopropanol (7 parts): 1 percent aqueous NH_3 (3 parts); (v) 5 percent (by volume) acetic acid in water. Positions of all absorbing materials on the chromatograms were noted with the aid of a Mineral Light ultraviolet lamp (principal emission, 2537 A). Results pertinent to this discussion are summarized in Table 1. By extraction of absorbing materials, followed by spectrophotometric measurements, it was determined that the mutants that accumulate hypoxanthine contain from 1 to 3 μg of the purine per animal (approximately 1 mg wet weight).

Chromatograms of excretion products scraped from the walls of culture bottles yielded a picture similar to that indicated in Table 1.

For the isolation of hypoxanthine, 50 g of washed adult *ry*^{2} flies were extracted with 350 ml of boiling water. After filtration and addition of a concentrated solution of lead acetate (3 g), the solution was adjusted to *p*H 9 with NH_4OH. After centrifugation, the precipitate was discarded and the supernatant was adjusted to *p*H 10. The resulting precipitate was removed by centrifugation, resuspended in water and treated with H_2S. The supernatant solution, after removal of lead sulfide, was evaporated to dryness and then extracted with 2 ml of hot water. This extract was streaked on a sheet of Whatman No. 4 paper and chromatogramed in solvent i (Table 1). Absorbing material (2537 A) at the hypoxanthine position was eluted with water, and chromatography was repeated with solvent v (Table 1). The eluate from the second chromatogram was evaporated to dryness, and the product was dissolved in 1 ml of hot water. Following treatment with a small amount of charcoal, the purine was crystallized from hot water with addition of ethanol to a slight turbidity. The yield after two recrystallizations was 5.5 mg. The product was chromatographically identical with hypoxanthine in the five solvents given above. It was also identical with hypoxanthine with respect to absorption spectra in 0.1*N* NCl ($\lambda_{max.} = 248$ mμ; log $E_{max.} = 4.03$) and in 0.1*N* NaOH ($\lambda_{max.} = 261$ mμ; log $E_{max.} = 4.06$).

Although hypoxanthine has been isolated in a pure form only from *ry*^{2} mutant, chromatographic and spectral characteristics of corresponding materials from the other mutants are in excellent agreement with the conclusion that the mutants tested accumulate and excrete hypoxanthine in the place of uric acid. It should also be noted that *ry*^{1} and *ry*^{2} may be genetic duplicates but that *ma-l* represents quite a different genetic locus. Nevertheless, the morphological and biochemical phenotypes are surprisingly similar. It is also of interest to note that in *Drosophila* the degradation of purines and their excretion as uric acid are not essential, nor is hypoxanthine particularly toxic to the animal even in the large quantities accumulated. However, at higher temperatures the *ry*^{2} mutant behaves as a late pupal or early imaginal semilethal (*1*), and it is possible that the purine accumulation is a contributory factor to this phenomenon (*8*).

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8. This work was supported in part by funds from the National Science Foundation and from the Atomic Energy Commission [No. AT (04-3-41)]. One of us (E. H.) is indebted to the Rockefeller Foundation for a travel grant which has aided continued cooperation on this and related problems.

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Partial Pressure of Ammonia in Alveolar Air

Abstract. The partial pressure of ammonia in alveolar air was measured and found to be the same (within the limits of experimental error) as the calculated partial pressure of ammonia in arterial plasma. It is likely that ammonia is equilibrated between alveolar air and the blood during its passage through the pulmonary capillaries.

The feeding of ammonium salts to cirrhotics or to dogs and human beings with portocaval shunts induces symptoms which are similar to those of hepatic coma (*1*). Ever since the work of Hahn *et al.* (*2*), evidence has been presented at times linking elevated blood ammonia levels and hepatic coma. However, Conway's (*3*) extensive studies and his conclusion that there is no ammonia in normal blood have led to controversy over the interpretation of measurements of blood ammonia. Recently we have suggested (*4*) that it might be the free rather than the total blood ammonia which is of significance in the clinical manifestations of hepatic coma, and that therefore we might find a better correlation with the partial pressure of ammonia (P_{NH_3}). Measurement of alveolar P_{NH_3} and comparison of it with the P_{NH_3} calculated from the plasma *p*H and total ammonia would help in the resolution of this problem. Poppell (*5*) has demonstrated the presence of ammonia in the expired air of dogs with Eck fistulas and of normal dogs. This encouraged us to attempt more quantitative measurements (*6*).

Mongrel dogs with portocaval shunts were deeply anesthetized with Nembutal (*7*). Because of the possibility of ammonia formation by bacterial action in the mouth, tracheal intubation was used. A double glass cannula with inflatable balloon was inserted into the trachea to within a few inches of the carina. The dog was ventilated via one side of the cannula with H_2SO_4-washed air by means of a variable speed respirator. End-expiratory air, sampled through the other half of the cannula by means of a variable speed pump (*8*), was passed through two ammonia absorbers in series and collected into a Douglas bag. The sampling was controlled by a valve in the cannula which was synchronized with the respirator to open at the end of expiration and close before the start of inspiration. During the gas-sampling period, two samples of arterial blood were taken anaerobically into heparinized syringes. Temperature was recorded by an oesophageal telethermometer. In test runs in which a 5-gallon gas reservoir was used in place of the dog, no ammonia was ever picked up in the ammonia absorbers.

The *p*H of the blood was measured with a Cambridge model R *p*H meter with a water-jacketed glass electrode. Plasma CO_2 was determined by the Van Slyke (*9*) manometric method, and the P_{CO_2} was calculated from the factors given by Milch *et al.* (*10*). The CO_2 in the gas sample was measured by the Scholander micromethod (*11*). The total plasma ammonia was measured by a modification of the method of Seligson and Hirahara (*12*). The P_{NH_3} of plasma was calculated, using the solubility coefficients for human plasma (*13*). The ammonia in the expired air was collected in a column of glass beads moistened with .02*N* H_2SO_4, in a 250-ml cylindrical separatory funnel. The ammonia was then released with saturated K_2CO_3, diffused to a drop of acid on a glass rod in the stopper, and determined with Nessler's reagent.

The results are summarized in Table 1. The last two columns show, respectively, the measured alveolar P_{NH_3} and the arterial P_{NH_3} calculated from the plasma total ammonia, the *p*H, and the solubility coefficient of ammonia (*13*). The correspondence between the two is very good, considering the cumulative errors in the experiments and particularly considering the fact that the alveolar P_{NH_3} is an average over a fairly long collection period whereas the calculated plasma P_{NH_3}'s are for two points in the collection period.

Recently we have measured the ammonia in the alveolar air of two normal dogs and have again obtained adequate checks between the measured alveolar P_{NH_3} and the calculated arterial P_{NH_3}. Although equilibration periods of at least 1 hour were used prior to the collection periods, arterial blood *p*H's varied by ± .02 *p*H units, and occasionally by more, and the plasma total ammonia often changed somewhat. The check between the alveolar P_{NH_3} and the calculated plasma P_{NH_3} is independent corroborative evidence that the total plasma ammonia measured by our method (*12*) is of the correct order of magnitude and corresponds to the amount present in plasma in vivo. Our measurements of normal human blood ammonia have checked with those of Calkins (*14*), who found, by means of Conway's method, a mean value of 0.8 μg of NH_3 nitrogen per milliliter of normal human blood. It would appear that the statement of Conway that there is less than 0.1 μg of NH_3 nitrogen per milliliter of normal blood may be incorrect. The difference in results may be accounted for by variations in the technique of handling the blood samples, since Conway's method is sound.

Our measurements establish that (i) ammonia is present in alveolar air and (ii) the amount present is of the order

Table 1. Alveolar P_{NH_3} experiments. Each experiment occurs as a double entry corresponding to the two arterial blood samples. In each experiment there was one gas collection. The two arterial samples were taken during the gas collection period.

Date	Dog No.	Gas: Temp. of dog (°C)	Gas: Collection time (min)	Gas: Vol. (lit. STPD)	Gas: P_{CO_2} (mm-Hg)	Arterial: *p*H	Arterial: CO_2 (meq/lit.)	Arterial: P_{CO_2} (mm-Hg)	Alveolar air NH_3 (10^{-4} meq)*	Arterial plasma NH_3 (meq/lit.)	Alveolar air P_{NH_3} (10^{-4} mm-Hg)	Calcd. arterial P_{NH_3} (10^{-4} mm-Hg)
2/5	x874	37	202	101	34.8	7.41	26.7	41.3	5.4	0.178	1.0	1.0
2/5	x874	36.9	202	101	34.8	7.43	25.8	38.2	5.4	0.112	1.0	0.7
2/10	B45	37.3	135	72.9	29.4	7.41		35.9	3.9	0.26	1.0	1.5
2/10	B45	37.3	135	72.9	29.4	blood sample lost			3.9		1.0	
2/12	x874	37.0	120	68.4		7.41			4.6	0.212	1.1	1.2
2/12	x874	36.8	120	68.4		7.40			4.6	0.213	1.1	1.2
2/17	x874	37.0	149	65	30.5	7.38	18.0	29.8	3.0	0.131	0.7	0.7
2/17	x874	37.2	149	65	30.5	7.43	21.1	31.3	3.0	0.123	0.7	0.8
2/19	x1100†	39.0	80	50.7	18.5	7.54	16.6	19.3	2.0	0.097	0.6	0.9
2/19	x1100†	38.8	80	50.7	18.5	7.53	15.6	18.6	2.0	0.099	0.6	0.9
2/24	x1100	37.0	110	57.4	42.3	7.38	27.7	45.9	1.5	0.119	0.4	0.6
2/24	x1100	37.3	110	57.4	42.3	7.39	25.8	41.8	1.5	0.132	0.4	0.7
2/26	x916‡	36	110	81		6.99	28.4	107.6	2.4	0.40	0.5	0.8
2/26	x916‡	36.2	110	81		6.99	27.3	103.4	2.4	0.185	0.5	0.4
3/3	x1100‡	37.8	100	65.4		7.00	32.5	123.1	1.6	0.150	0.4	0.4
3/3	x1100‡	37.6	100	65.4		7.02	31.9	118.6	1.6	0.188	0.4	0.5

* The volume of alveolar air collected was calculated as the volume of gas collected multiplied by the ratio of the gas P_{CO_2} to the arterial P_{CO_2}. In the three experiments in which gas P_{CO_2} was not measured, the volume of gas collected was used for the alveolar air collected.
† Hyperventilated.
‡ Ventilated with a mixture of 10 percent CO_2 and 90 percent O_2.

of magnitude expected if the ammonia in the blood were to equilibrate with the alveolar air during its passage through the pulmonary capillaries. Considering the high diffusibility of NH_3, this was to be expected. The measurements of Robin *et al.* (*15*) on dogs infused with ammonium acetate lead to the same conclusion. We have recalculated the arterial P_{NH_3} for dogs 5 and 7 of their Table 2, using our values for the solubility coefficient and K_a' (*13*), and obtain 4.5×10^{-4} and 3.2×10^{-4} mm-Hg for dogs 5 and 7, respectively; this indicates that Robin *et al.* obtained a better check than was suggested by their calculations.

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6. In the course of this work we learned that E. D. Robin, D. M. Travis, T. A. Bromberg, C. E. Forkner, Jr., and J. M. Tyler had independently started similar measurements on dogs infused with ammonium acetate to elevate the blood ammonia. Their work is also reported in this issue. Our studies were supported in part by grants C-2697 and CS-9261 from the U.S. Public Health Service, and by the Andre and Bella Meyer Fund.
7. We wish to thank Dr. Walter Lawrence for allowing us to use his portocaval shunt preparations for these measurements.
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Ammonia Excretion by Mammalian Lung

Abstract. The intravenous administration of ammonium acetate to dogs results in measurable levels of free ammonia in expired air. Simultaneous measurement of the physiologic dead space permits the calculation of the partial pressure of ammonia in alveolar air. This finding has implications for ammonium metabolism and transport.

Studies in fish have shown that ammonia excretion can occur by means of diffusion across the gill membranes (*1*). The excretion of ammonia by mammalian lung has not been previously investigated (*2*). The concentration of ammonium ion in normal human and dog blood is small (*3*). According to current theory, blood ammonium should be present in at least two forms: as ammonium ion (NH_4^+) and as the free gas, ammonia (NH_3). The pK of this buffer system in 0.15M saline at 38°C is 9.5; hence, at the usual pH of mammalian blood, the quantity of free ammonia (NH_3) would be small.

If the concentration of total ammonium in the blood is increased, it should be possible to elevate the concentration of free NH_3 in pulmonary capillary blood sufficiently so that it would appear in a measurable quantity in expired air, having traversed the alveolar membrane by simple diffusion. During a steady state, simultaneous measurements of the fractional concentration of NH_3 in expired air and the size of the dead space of the lung should provide a quantitative estimate of the partial pressure of NH_3 in alveolar air. This report describes experiments in which these measurements have been performed (*4*).

Seven mongrel dogs weighing approximately 15 kg each were studied. Following Nembutal anesthesia, 100 milliequivalents (meq) of $NaHCO_3$ was administered to each dog intravenously to elevate blood pH and increase the fraction of total ammonium present as NH_3. The air expired by the dog was bubbled through 10 ml of 0.1N HCl for 20 minutes to serve as a control. After the control period, 0.2M ammonium acetate was infused intravenously at a constant rate for periods of time ranging from 46 to 90 minutes. During the administration of ammonium acetate the air expired by the dog was permitted to bubble through a fresh solution of 0.1N HCl; this converted any free NH_3 in the expired air to NH_4Cl. Midway during the experimental period, measurements of arterial CO_2 tension, expired air CO_2 tension, and the volume of expired air were made by standard methods (*5*).

The concentrations of ammonium present in the control and experimental samples were determined by nesslerization. The volume of the respiratory dead space was calculated by means of the Bohr equation (*6*). On the assumption that NH_3 was distributed in the same dead space as CO_2, it was possible to calculate the partial pressure of ammonia in alveolar air, as follows:

$$\frac{\text{Mg of } NH_3 \text{ excreted}}{\text{min}} = \frac{(\text{mg of } NH_3/\text{ml} \times \text{vol of } 0.1N \text{ HCl})}{\text{time}}$$

$$F_{E(NH_3)} = \frac{\text{mg of } NH_3/\text{min}}{\text{ml of air expired/min}} \times \frac{22.1}{17}$$

$$V_A/V_E = P_{E(CO_2)}/P_{a(CO_2)}$$

$$P_{E(NH_3)} = \text{barometric pressure} \times F_{E(NH_3)}$$

$$P_{A(NH_3)} = P_{E(NH_3)}/(V_A/V_E)$$

where $F_{E(NH_3)}$ is the fractional concentration of NH_3 in expired air; V_A/V_E is the ratio of alveolar ventilation to total ventilation; $P_{E(CO_2)}$ is partial pressure of CO_2 in expired air; $P_{a(CO_2)}$ is partial pressure of CO_2 in arterial blood; $P_{E(NH_3)}$ is partial pressure of NH_3 in expired air; and $P_{A(NH_3)}$ is partial pressure of NH_3 in alveolar air.

In two dogs simultaneous measurements of arterial pH and total blood ammonium concentrations were made. By applying the Henderson-Hasselbalch equation, it was possible to *estimate* the theoretical partial pressure of ammonia in arterial blood. In four dogs the completeness of extraction of ammonia by the 0.1N HCl solution was tested by means of rebubbling expired air through a second aliquot of 0.1N HCl.

Table 1 summarizes the data obtained from the seven dogs that were studied. During control periods no measurable amount of NH_3 was found in expired air. In each dog ammonium acetate administration produced measurable quantities of NH_3 in expired air. The quantity of NH_3 in air was small, averaging 3.8×10^{-7} ml per milliliter of air. However, since the ammonia content of large volumes of air was concentrated by the technique employed, it was possible to measure $F_{E(NH_3)}$ and calculate the partial pressure of NH_3 in alveolar air. The average $P_{A(NH_3)}$ for the seven dogs was 7×10^{-4} mm-Hg. Table 2 shows the arterial levels of total ammonium in the two dogs in which it was measured and the estimated arterial NH_3 tensions [$P_{a(NH_3)}$]. The order of magnitude of the two values [$P_{a(NH_3)}$ and $P_{A(NH_3)}$] is similar.

Complete extraction of ammonia by the first aliquot of 0.1N HCl was found in the four studies in which a rebubbling technique was used.

Although the quantity of free ammonia in alveolar air (and thus, presumably, in pulmonary capillary blood) is small, its physiologic significance may be great. Jacobs (*7*) has pointed out that cells may be impermeable to a given ion but may

Table 1. Alveolar ammonia tensions and related data in seven dogs following ammonium acetate administration.

Dog No.	Ammonium acetate administered (meq)	Time of administration (min)	Total NH_3 excretion (mg)		$F_{E(NH_3)}$ (10^{-7} ml/ml)	$P_{E(NH_3)}$ (10^{-4} mm-Hg)	$P_{a(CO_2)}$ (mm-Hg)	$P_{E(CO_2)}$ (mm-Hg)	V_A/V_E	pH	$P_{A(NH_3)}$ (10^{-4} mm-Hg)
			Control	Experimental							
1	80	90	0	0.073	1.7	1.3	41	12	0.29	7.39	4
2	125	60	0	0.098	4.4	3.3	56	19	0.33	7.36	10
3	100	46	0	0.093	4.7	3.6	41	17	0.41	7.59	9
4	100	64	0	0.079	6.1	4.7	31	16	0.51	7.50	11
5	100	71	0	0.052	1.9	1.5	54	16	0.30	7.48	5
6	115	60	0	0.063	3.3	2.5	37	16	0.43	7.58	6
7	100	70	0	0.044	3.0	2.3	58	22	0.26	7.40	6

be permeable to the free base of this ion. Robin *et al.* (*8*) have shown that the spinal fluid compartment is permeable to CO_2, a gas, but is relatively impermeable to bicarbonate ion. Free ammonia, a gas, presumably is freely diffusible. This may be the form in which ammonium is transported across cell membranes. The diffusivity of NH_3 may be compared to the diffusivity of O_2 and CO_2 by means of Graham's and Henry's laws. Such calculations show that NH_3 is approximately 30,000 times as diffusible as O_2 and 1500 times as diffusible as CO_2. Under these circumstances it would be expected that NH_3 equilibrium would occur very rapidly indeed across the alveolar membrane. Alveolar and pulmonary capillary NH_3 tensions would thus be essentially equal.

It is important to emphasize that, at present, *accurate* calculations of arterial NH_3 tensions from experimentally determined total arterial ammonium levels and arterial *p*H are not possible. Such calculations would require an accurate value for the equilibrium constant, K_a, of the reaction

$$NH_4^+ \rightleftarrows NH_3 + H^+$$

in blood or plasma, which is certainly different from its value in aqueous solution. Until an acceptable plasma K_a is available, only order-of-magnitude comparisons between alveolar and arterial NH_3 tensions are warranted.

During the past 5 years major emphasis has been given to the role of ammonium metabolism in man. Significant concentrations of total ammonium have been found in the blood of patients with various types of liver disease. An increase in blood ammonium has been implicated in the pathogenesis of hepatic coma. However, correlations between blood ammonium concentrations and the degree of hepatic coma are imperfect. It is generally accepted that the measurement of blood ammonium presents great technical difficulties. Since there may be spontaneous generation of ammonium from nitrogenous substances in blood, the exact significance of blood ammonium levels, after shedding, is difficult to assess.

The demonstration of free NH_3 in alveolar air may be taken to indicate that under special circumstances there are significant levels of circulating ammonium. Jacquez, Poppell, and Jeltsch have demonstrated free NH_3 in the alveolar air of dogs with Eck fistulas (*2*). Preliminary studies in some patients with hepatic coma have shown measurable levels of ammonia in expired air (*9*). By utilizing the lung of such a patient as a tonometer, it may be possible to reassess the quantitative aspects of ammonium metabolism and its relation to hepatic coma.

It is interesting to note the similarities between NH_3 and CO_2. Both are gases which are involved in metabolic processes. Under physiologic circumstances neither is present in significant quantity in inspired air. Both gases are highly diffusible. Each gas exists in equilibrium, with an ion constituting a buffer pair. As with CO_2, the study of the excretion of NH_3 by mammalian lung may prove to be a useful approach for further investigation of gas exchange.

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Table 2. Comparison of estimated arterial and experimentally determined alveolar ammonia tensions.

Dog No.	Arterial ammonium concentration (μmole/lit)	Arterial *p*H	Estimated arterial ammonia tension $P_{a(NH_3)}$ (10^{-4} mm-Hg)	Alveolar ammonia tension $P_{A(NH_3)}$ (10^{-4} mm-Hg)
5	610	7.48	1.7	5
7	520	7.40	1.2	6

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3. This investigation was supported in part by a research grant (H2243) from the National Heart Institute of the National Institutes of Health, Public Health Service, and in part by a grant from the Massachusetts Heart Association. We are grateful to Dr. A. B. Hastings for advice and encouragement in the course of this study; to Drs. Rudi Schmid and Charles S. Davidson for the measurements of arterial ammonium concentrations: and to Drs. Jacquez, Poppell, and Jeltsch for their cooperation and assistance.
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A Case of Ovotestes in the Sea Urchin Strongylocentrotus Purpuratus

Abstract. A hermaphroditic sea urchin, *Strongylocentrotus purpuratus*, with three ovotestes and two testes is described. Neither cleaving eggs nor embryos were found *in corpore*. Fertilization *inter se* gave normal larvae. The specimen was collected from Palos Verdes, Calif., a region which has yielded an unusually large number of hermaphroditic *S. purpuratus*.

In a former report we listed known cases of hermaphroditism in echinoids, discussed the exceptional occurrence of ovotestes, and mentioned other publications in which such cases are recorded (*1*). On 19 Jan. 1958 one of us (R.A.B.) collected 30 specimens of *Strongylocentrotus purpuratus* at Palos Verdes, Los Angeles County, Calif. This is in the region which has yielded an unusually large number of hermaphroditic *S. purpuratus* (1 to 500), according to the report of Albert Tyler (*2*). One of the specimens collected at Palos Verdes, when opened, was found to contain both ovaries and testes. This specimen weighed 24.4 g and had a test diameter of 38.4 mm. The five gonads comprised two testes and three ovotestes. In the latter, the ovary occupied the dorsal half and the testes the ventral half, hence only the eggs could escape. The gonads were ripe and easily broken. No

cleaving eggs or embryos were found *in corpore*.

Eggs and sperm from each of the ovotestes were isolated in dishes of sea water. Fertilization *inter se* gave entirely normal larvae. Normal eggs fertilized with sperm from the ovotestes gave normal larvae, as did also the eggs of the ovotestes fertilized with normal sperm.

Subsequently all five gonads were preserved and sectioned. There were thus three types of section: ovarian, testicular, and ovotesticular (from the median zone). Both ovarian and testicular lobes showed normal structure, with masses of ripe and immature eggs or sperm, as the case might be. In the median section, where the ovarian and testicular structures lie side by side, the acini were intermingled. Ripe ova occurred among the sperm. A few eggs showed fertilization membranes, which must have been the result of the recent handling, since no division stages or embryos were found *in corpore*.

It is worthy of note that in a similar hermaphroditic specimen of *Strongylocentrotus pulcherrimus*, Okada and Shimoizumi (*3*) found that, when selfed, the eggs and sperm resulted in imperfect larvae, while larvae resulting from outcrossing were normal. Thus, their findings differed from those in the experiments described above (*4*).

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4. This study was aided by a University of California research grant.

25 August 1958

"Shutoff Pulse Illusion"

Abstract. Visual signals produced by sharp illumination decrements are commonly misinterpreted because of the presence of an illusory sharp increment at the moment of switching. Conditions for occurrence of the illusion are outlined, as well as conditions under which it is not reported.

During evaluation of a device in which information was tranmitted by means of a step-modulated light beam, the visual appearance of certain light signals was found to disagree consistently with these same signals as electronically received and recorded. The discrepant element in all instances was found to be a positive pulse of short duration, reported when the illumination ceased or declined sharply. This illusory signal, here called the "shutoff pulse," is shown diagrammatically in Figs. 1*A* and 1*B*. It was noted regardless of whether the light source was a high-temperature filamentary lamp or a glow lamp, provided the lamp supply was direct-current; it was noted at all supply frequencies above about 40 cycles/sec with high-temperature filamentary lamps and at all supply frequencies above about 250 cycles/sec with glow lamps. It was not noted with low-temperature filamentary lamps, and it was masked by flicker and stroboscopic effects at low supply frequencies.

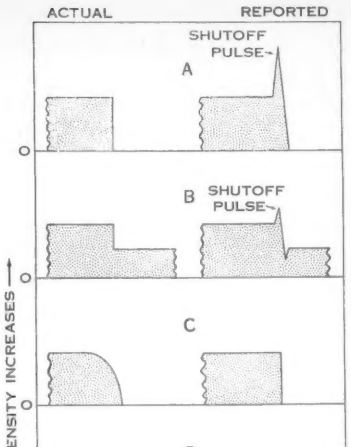

Fig. 1. Conditions associated with "shutoff pulse" illusion.

The illusion could be lessened or removed entirely by "fading" the light source in place of "stepping" it, as shown in Figs. 1*C* and 1*D*, but the amount of "rounding" seemed to be different for different observers, and some inconsistencies suggested hour-to-hour changes for the same observer.

No simple relation could be observed between the rate of change of illumination and the observed "iris overshoot" of the observer. This well-known "hunting" phenomenon is an oscillatory change in the iris aperture in response to a rapid change in illumination. When illumination changes by a factor of 2, the iris attains a new equilibrium aperture in from 50 to 250 msec with most subjects. When the rate of change of illumination was slow enough for the iris overshoot to be undetectable, the "shutoff pulse" was never reported.

The conditions for maximum illusory effect appear to be moderate illumination, light intensity change by a factor of 2 or more, and illumination filling at least several degrees of the observer's visual field. With very strong illumination, the illusion, if present, is masked by afterimages. At very weak illumination, it is not reported. If the change in light intensity is very small, the illusion is not reported, and, in some instances, the step modulation is not perceived.

When the key light source is not only weak but also fills only a small portion of the observer's visual field, such as 30 min of arc, the shutoff pulse is not reported. If the light is near the edge of the observer's visual field and is relatively weak, he is likely to report that "it moved" when the intensity is keyed.

This illusion is possibly related to some phenomena recently reported by Baker (*1*) and Bouman (*2*). It is roughly analogous to the subjective portions of the "key click" problem, which has plagued the wire and radio-communications industries since their inception, and the "shutoff pulse" illusion is one of the reasons why keyed or step-modulated light beams, with visual reception, are not a satisfactory means of rapid communication.

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11 August 1958

Venom of the Stonefish

Synanceja verrucosa

Abstract. Moderate doses in rabbits produced hypotension, increased respiratory rate, and myocardial injury. Respiratory arrest occurred with fatal doses when the blood pressure had declined to very low values. The active substance (or substances) was nondialyzable, and the potency of the protein-containing lyophilized or glycerol-treated extracts was maintained well on prolonged storage.

Stonefishes of the genus *Synanceja* have caused a number of deaths in human beings through stings by the venomous spines (*1, 2*). Two large venom sacs are present on each of the 13 dorsal spines, and much smaller ones on two pelvic and on three anal spines (*1*). Wounds have occurred commonly on the hand or foot as a result of punctures by the dorsal spines of the fish, which inhabits shallow water over wide areas of the tropical Indian and Pacific oceans. Extreme pain ensues within a few minutes after the sting and then spreads from the wound over the entire extrem-

ity. Ischemia and edema soon appear, and complete recovery from the local effects may be delayed for days or weeks. Systemic effects include weakness, sweating, respiratory distress, and convulsions; death may occur within a few hours (*1–3*). Duhig and Jones (*4*) and Gail and Rageau (*5*) have described the behavior of a few animals injected with stonefish venom; in addition, a hemolytic action has been reported (*6*). However, no data are available on the nature of the systemic effects of the venom or on the properties of the active substance (or substances).

Specimens of *Synanceja verrucosa* Bloch and Schneider were collected at depths of 25 feet or less at Parry Island, Eniwetok Atoll, Marshall Islands, and were maintained alive in the aquarium until used (*7*). The mean weight of the fish was approximately 2 kg; the mean standard length, 30 cm. The 13 dorsal spines were removed, and the thick outer integumentary sheath of each spine was peeled away, revealing two large, attached venom sacs. Extracts were prepared at 3°C, either by slitting open the sacs under 0.9-percent NaCl solution or by aspirating the fluid venom from the sacs and adding it to 0.9-percent saline. The extract was centrifuged at approximately 500 *g* for 5 minutes and the clear, colorless supernatant (*p*H approximately 6.8) was decanted from a small amount of precipitate. Suitable dilutions of the extracts were injected intravenously into tail veins of albino mice (mean weight 25 g). The animals died in about ½ to 30 minutes, depending upon the dose; animals which did not die within ½ hour usually survived indefinitely. Injected venom in amounts fatal within 2 to 5 min produced any or all of the following symptoms initially: ataxia, circling movements, and partial or complete paralysis of the limbs. A period of inactivity usually followed, after which violent rolling or pedaling movements occurred for about 15 seconds prior to respiratory arrest and death.

The undiluted venom aspirated from the sacs (0.03 to 0.07 ml per spine) was a clear, colorless fluid with an average nitrogen content of approximately 2 percent and a protein content (biuret determination) of approximately 13 percent. The total solids amounted to about 14 percent. The mean LD_{50} of freshly prepared extracts in mice was approximately 200 µg of protein per kilogram (range, 148 to 276 µg/kg) or 30 µg of nitrogen per kilogram; 10,000 to 25,000 LD_{50} doses for mice were present in extracts prepared from individual fish. Dialysis of extracts for 24 hours at 2°C in Visking cellulose casing against 0.9-percent NaCl solution indicated that the material lethal to mice was nondialyzable.

Extracts prepared from freshly killed specimens were adjusted to *p*H 7.5 and preserved by lyophilization or by the addition of glycerol to a final concentration of 40 percent. The samples (in sealed glass vials) were maintained for about 1 week in Dry Ice and subsequently were maintained at −20°C. Bioassays of representative glycerol-treated and lyophilized samples after 1 year of storage have indicated that 50 to 100 percent of the original activity was retained. The symptoms produced in mice with these stored samples appeared identical with those evoked by freshly prepared extracts. Spines were also removed from fish and stored at the afore-mentioned temperatures in sealed polyethylene bags for 10 months; extracts prepared after this period were of comparable potency and produced in mice the same symptoms as did extracts prepared from freshly killed fish.

Experiments were performed to determine the nature of the systemic effects of the venom. Twelve rabbits (average weight about 2 kg) were anesthetized with urethane (1 to 1.5 g/kg) intraperitoneally. Blood pressure was recorded from a carotid artery; the respiration was recorded, and electrocardiographic tracings were obtained simultaneously. Venom extracts were injected into a jugular vein. Lyophilized and glycerol-treated samples produced the same responses. Injection of small doses produced a slight fall in blood pressure accompanied by an increase in respiratory rate, with no electrocardiographic changes; these effects disappeared within about 5 min. Larger doses caused a more marked fall in blood pressure and an increase in respiratory rate which was sometimes accompanied by a period of decreased depth of respiration. There was evidence of myocardial ischemia or injury (inversion of the T wave in some animals, and marked displacement of the S-T segment in all animals), despite the absence of significant changes in the heart rate. All effects had disappeared after about 10 minutes (Fig. 1, *A*).

Injection of fatal doses produced similar effects initially; additional electrocardiographic changes (for example, occasional premature auricular and ventricular impulses, first-degree atrioventricular block, ventricular tachycardia, ventricular fibrillation) occurred as the blood pressure continued to decrease. The respiration then slowed and often became gasping for ½ minute or less and finally ceased in inspiration (in approximately 1.5 minutes in the typical experiment illustrated in Fig. 1, *B*); cardiac standstill followed within a few minutes. The auricles (and sometimes the ventricles) were usually still beating when the chest was opened, approximately 1 minute after respiratory arrest. The mean lethal dose in these experiments was approximately 10 µg of protein per kilogram.

The above results indicate that the primary action of the venom upon the cardiovascular system is the production of a marked hypotension, which is associated in the case of larger doses with

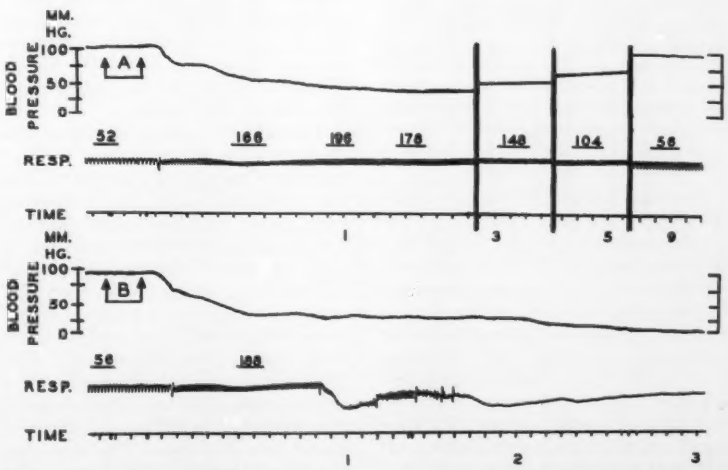

Fig. 1. Effect of venom of *Synanceja verrucosa* upon the blood pressure and respiration of a rabbit. The space between the arrows at *A* (top) indicates the interval during which 7.7 µg of venom protein per kilogram was injected; at *B* (bottom), the interval during which 11 µg/kg was injected 25 min later. The heavy vertical lines in the upper record indicate interruption of the recording. The numbers above the record of respiration indicate the respiratory rate per minute during the time interval denoted by the horizontal lines beneath these numbers. Signal marks at 5-second intervals and the numbers below the signal marks indicate time (minutes) after injection of venom. Inspiration is indicated by the downward stroke on the respiration record.

injury to the myocardium; whether these cardiac effects are due to a direct action of the venom upon the myocardium or coronary vessels or are secondary to the hypotension remains to be determined (*8*).

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7. This paper represents results of research carried out by the University of Southern California under contract with the Office of Naval Research. I am grateful to the Scripps Institution of Oceanography, University of California, and in particular to Prof. D. L. Fox of that institution, for the use of facilities during this investigation, and to the Atomic Energy Commission for general assistance and the use of facilities of the Eniwetok Marine Biological Laboratory, Marshall Islands. I also wish to thank Dr. D. W. Strasburg, Pacific Oceanic Fishery Investigations, U.S. Fish and Wildlife Service, Honolulu, T.H., for identification of the specimens used, and Mr. Peter B. Taylor for technical assistance in portions of this work.
8. This report is a contribution from the Scripps Institution of Oceanography, new series.
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Purification of Folic Acid

Abstract. Various purification procedures for folic acid were investigated. The criteria of purity were a negative Bratton-Marshall test and the absence of fluorescent spots on paper chromatograms. Since no method provided a pure product, a procedure consisting of cellulose column chromatography followed by filtration through charcoal was developed.

Commercial folic acid contains a number of impurities, principally photochemical decomposition products. At least one of these substances, 2-amino-4-hydroxypteridine-6-aldehyde, has an intense effect on certain enzymes. It strongly inhibits the enzyme (or enzymes) of milk that oxidizes xanthine (*1–3*), xanthopterin (*1–3*), and 2-amino-4-hydroxypteridine, (*3*), as well as liver xanthopterin (*1*) and quinine oxidase (*1*). This report (*4*) describes the purification of folic acid by chromatography on cellulose powder followed by filtration through charcoal.

Various other purification procedures have been investigated—washing with dilute HCl solution (*5*), charcoal treatment and recrystallization (*6*), and crystallization of calcium foliate followed by charcoal treatment (*7*). The purity of the products was studied by paper chromatography and by determination of *p*-aminobenzoylglutamic acid by the Bratton-Marshall procedure (*8*). Since folic acid undergoes photochemical decomposition (*7*), all operations were carried out under dim illumination.

Descending paper chromatograms, 30 cm long, or more, were prepared; 2-cm² spots of neutral sodium foliate solution on Whatman No. 1 paper and two solvent systems—0.2*M* sodium phosphate buffer (*p*H 7.0) saturated with isoamyl alcohol (*9*) and *n*-butanol:acetic-acid:water (4:1:5) (*5*)—were used. When the phosphate buffer was used, 0.1-mg samples of folic acid were chromatographed. Three ultraviolet-fluorescing spots (R_f 0.48, 0.33, and 0.13, respectively) and a single ultraviolet-absorbing spot [R_f 0.40 (sodium foliate)] were present on chromatograms of the commercial product.

When the *n*-butanol:acetic-acid:water system was employed, denser (0.25 mg) spots were used, since sodium foliate does not move in this solvent. Three fluorescent spots (R_f 0.38, 0.26, and 0.11, respectively), and a single ultraviolet-absorbing spot (R_f 0) were visually detectable on chromatograms of commercial folic acid. The first two spots were decomposition products of the pteridine portion of the folic acid molecule (*5*).

The absence of fluorescent spots on the chromatograms and a negative test for diazotizable amine (*p*-aminobenzoic acid and *p*-aminobenzoylglutamic acid) were employed as the criteria of folic acid purity.

Since none of the purification procedures that were studied yielded a pure product, the problem was investigated, and the method described below was developed. The procedure involves a combination of cellulose chromatography and filtration through charcoal.

The cellulose column is prepared in the following manner. Two hundred grams of Whatman standard-grade cellulose powder are mixed with 0.1*M* phosphate buffer (*p*H 7) saturated with isoamyl alcohol. After it has stood for ½ hour, the mixture is poured into a tube (7.5 by 55 cm) plugged with cotton. The cellulose is packed to a height of 40 cm by suction, covered with a circle of heavy filter paper (Eaton-Dikeman No. 627-030), and compressed with a plunger to a final height of 37 cm. The column is then washed with 500 ml of buffer and placed in a dark room. The remaining operations should be carried out under dim illumination.

Commercial folic acid (550 mg) is suspended in 30 ml of water, and sufficient 1*N* NaOH is added to dissolve the folic acid. The solution [*p*H 7 (universal indicator paper)] is introduced into the column, and sodium foliate is moved down from the top with three 2-ml portions of the isoamyl-alcohol–saturated buffer. The column is then eluted with buffer at the rate of about 75 ml/hr. The yellow foliate band, which is clearly visible, is collected between approximately 550 and 730 ml of effluent. Since *p*-aminobenzoylglutamic acid is eluted just before folic acid, collection of the folic acid fraction should not be started until the effluent is distinctly yellow. If the folic acid band is so uneven that the folic acid fraction exceeds 200 ml, it probably will be contaminated with *p*-aminobenzoylglutamic acid.

Cellulose chromatography reduces the content of *p*-aminobenzoylglutamic acid (from 1 to 2 percent in commercial folic acid) to less than 0.02 percent. It also removes most, but not all, of the fluorescent material present in the folic acid. To remove the remaining trace, the folic acid is filtered through charcoal, as described below.

The eluate from the cellulose column is placed in a 250-ml polyethylene bottle, acidified to *p*H 2 (universal indicator paper) with 3*N* HCl, and centrifuged at 0°C in an International PR-1 refrigerated centrifuge. The sediment is then suspended in water and dissolved with sodium hydroxide, as previously described. It is important that the solution be completely clear, otherwise filtration will be extremely slow.

A charcoal column is prepared, an 8- by 100-mm chromatography tube being fused at the top to a 25- by 200-mm section of tubing. The tube is plugged with cotton and filled to a depth of 1 cm with cellulose powder, which serves to trap charcoal particles. A mixture of 0.5 g of Darco G-60 decolorizing charcoal and 1 g of cellulose powder is then slurried in water, poured into the tube, and held in place with a cotton plug. After the column has been washed with 25 ml of 6*N* HCl and 100 ml of water, the folic acid solution is filtered through the charcoal by suction. The column is washed until the effluent is colorless. Filtration through charcoal removes all of the fluorescent material remaining after cellulose chromatography.

Folic acid is recovered from the charcoal filtrate as follows. The solution is acidified to *p*H 2 with 3*N* HCl and centrifuged at 0°. The sediment is washed four times by stirring with 50-ml portions of 1-percent acetic acid and by centrifugation at 0°; it is then suspended in water and lyophilized. A pale yellow powder is obtained in a 70- to 75-percent over-all yield.

The product, which is completely pure according to the criteria that have been described, should be stored in the dark.

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15 September 1958

Significance of Mitochondria for Porphyrin and Heme Biosynthesis

Abstract. It is concluded that mitochondria are involved in three steps of porphyrin and heme biosynthesis—first, in the formation of δ-aminolevulinic acid from glycine and active succinate; second, in the synthesis of protoporphyrin; third, in the incorporation of iron into the porphyrin ring—that is, in heme formation.

It has long been believed that nonnucleated erythrocytes have no mitochondria. By phase-contrast microscopy, the senior author (*1*), in 1955, identified mitochondria in the basophilic stippled cells formed in lead poisoning. Recently Brunner *et al.* (*2*), Braunstein *et al.* (*3*), and Seno *et al.* (*4*) have reported that mitochondria are also present in reticulocytes. Measurements which we made of the high oxygen consumption and cytochrome-*c* content of these two blood cells support this conclusion (*5*). Chicken erythrocytes which have distinct mitochondria near the nuclear membrane showed higher oxygen consumption and cytochrome-*c* content than even the basophilic stippled cells of lead poisoning (*5*). Basophilic stippled cells have a high concentration of δ-aminolevulinic acid and protoporphyrin (*5*) and are as effective in synthesizing protoporphyrin from glycine (*5*) as are avian red cells and reticulocytes (*6*). Since in all these red-cell types the presence of mitochondria can be correlated with protoporphyrin synthesis, the exact role played by the mitochondria in this synthesis was investigated (*7*).

Hemolysates of washed chicken erythrocytes were made according to the method of Dresel and Falk (*8*). Mitochondria were prepared from rabbit bone marrow or rat liver by Schneider's method (*9*). Addition of bone-marrow mitochondria to a chicken red-cell hemolysate incubated with glycine doubled the amount of protoporphyrin synthesized, but this ability to stimulate synthesis of protoporphyrin was destroyed by prior homogenation of bone-marrow mitochondria (Fig. 1*A*). Addition of liver mitochondria, however, had the effect of decreasing markedly protoporphyrin formation, due to the high content of an oxidative deaminase for glycine in liver mitochondria.

When δ-aminolevulinic acid was used as substrate, basophilic stippled cells, reticulocytes, and chicken erythrocytes synthesized much protoporphyrin but little coproporphyrin or uroporphyrin (Fig. 1*B*). Mature rabbit erythrocytes, however, produced much uroporphyrin and coproporphyrin, with little protoporphyrin. This can be explained by the presence of mitochondria in the former cells, since, when liver mitochondria were added to preparations devoid of mitochondria, such as mature rabbit erythrocytes or the supernatant obtained by centrifuging chicken red-cell hemolysates, the mixture converted δ-aminolevulinic acid to protoporphyrin. In a typical experiment a chicken red-cell hemolysate supernatant (20 ml) was incubated for 4 hours with δ-aminolevulinic acid (2 mg), then rat-liver mitochondria were added and the incubation was continued for an additional 4 hours. Porphyrins were then determined and compared with values found in the controls—that is, in preparations with no added mitochondria. It was found that the yield of isolated coproporphyrin decreased promptly, whereas the yield of protoporphyrin was markedly elevated as compared to that of the controls. No protoporphyrin was produced by incubation of coproporphyrin with these mitochondria. The activity residing in the mitochondria could be extracted by water or phosphate buffer from a mitochondria acetone powder. Mitochondria from rabbit liver, chicken erythrocytes, bone marrow, and mesenteric lymph nodes possessed this activity but mitochondria from kidney, heart muscle, and intestinal mucosa did not. Similar effects were found when porphobilinogen was used as substrate.

It is believed that iron is only inserted

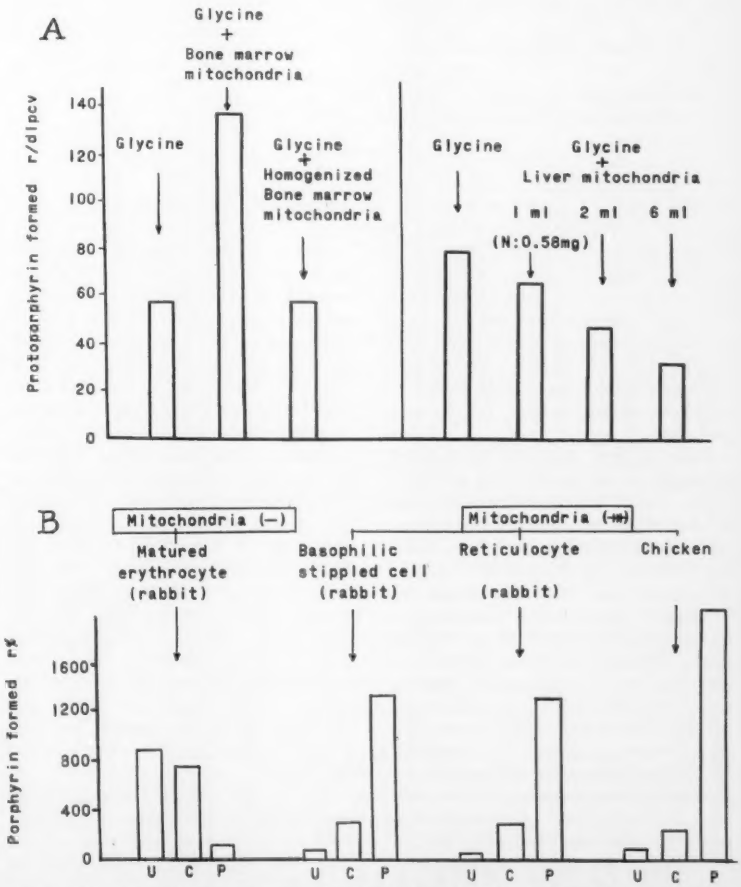

Fig. 1. (*A*) Effect of bone-marrow mitochondria and liver mitochondria on protoporphyrin biosynthesis from glycine in chicken red-cell hemolysate. Glycine, 0.028*M*; incubation period, 2 hours. (*B*) Differences in level of various porphyrins biosynthesized from δ-aminolevulinic acid (0.645 mmole) in erythrocytes containing mitochondria and in cells containing no mitochondria.

after complete formation of the protoporphyrin ring, but the enzyme system concerned is not yet known. We have investigated the role of mitochondria in this process. δ-Aminolevulinic acid was used as substrate and added to the following preparations: (i) chicken red-cell hemolysate supernatant; (ii) the same, plus rat-liver mitochondria; (iii) the whole chicken red-cell hemolysate; (iv) the whole chicken red-cell homogenate plus rat-liver mitochondria. Ferrous sulfate was added at the beginning of the incubation and also 4 hours after the beginning. It was demonstrated that addition of iron to the systems containing mitochondria brought about in each case a decrease in free protoporphyrin. It is thus very probable that mitochondria play an important role in the incorporation of iron into the porphyrin ring, but this supposition must be reexamined by means of labeled δ-aminolevulinic acid.

An attempt to localize the region of protoporphyrin formation within the living cell was made as follows: Chicken erythrocytes were incubated with glycine for 4 to 6 hours at 37°C, and the nuclear and cytoplasmic fractions were then separated by a modification of Schneider's method (*5*). It was found that protoporphyrin was present in the cytoplasm but not in the nuclei. When, however, the nuclear fraction was contaminated by mitochondria (contamination was determined by cytochrome-*c* oxidase), as is often the case when using Schneider's method, much protoporphyrin was to be found in the nuclear fraction. The livers of rabbits that had been fed Sedormid or allylisopropylacetamide were also used for this study. Much protoporphyrin was found in the mitochondria; little was found in the supernatant, microsomes, and nuclei.

These findings, together with the ones presented above, indicate that protoporphyrin can be synthesized and accumulated in the mitochondria. From the experiments described above, we concluded that mitochondria take part in three steps of porphyrin and heme biosynthesis. (i) They take part in the formation of δ-aminolevulinic acid from glycine and active succinate. Here the presence of uninjured mitochondria in the hematopoietic tissue is essential. (ii) They participate in some step or steps in the synthesis of protoporphyrin from δ-aminolevulinic acid. Here not only intact mitochondria of bone marrow, erythrocytes, liver, and mesenteric lymph nodes are active but also disrupted mitochondria or aqueous extracts of acetone powders of the mitochondria. (iii) Lastly, mitochondria appear to participate in the incorporation of iron into the porphyrin ring—that is, in heme formation.

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25 August 1958

Vitamin B_{12} in Sewage Sludges

In view of the reports by other workers on the occurrence of an appreciable amount of vitamin B_{12} in activated sludge (*1*, *2*) and on the possibility of increasing the B_{12} content of such sludge by adding small amounts of cobalt to sewage in the aeration tanks (*3*), we found it of interest to make a comparative study of the different types of sewage sludges from the point of view of vitamin B_{12} content (*4*). In this connection we examined raw sewage solids, raw sewage precipitated with chemicals such as lime and alum (0.75 g of the chemical per liter of sewage), septic sludge, and activated sludge. For all these sludges the source of the raw sewage was the same. *Epistylis* sp., a peritrichous ciliate protozoan occurring abundantly in the activated sludge tank, was also collected, repeatedly washed in clean water, and examined for its B_{12} content. For purposes of comparison, cow dung was also examined.

The sludges and other materials were treated with a few drops of 1-percent sodium cyanide and dried over a water bath. The B_{12} was extracted from the dried materials with 1-percent sodium acetate, *p*H 4.6, and the vitamin was assayed with *Lactobacillus leichmanii* ATCC 4797 as the test organism. The method employed was essentially the same as that of Skeggs *et al.* (*5*). The true vitamin B_{12} activity was determined by the alkaline destruction method. The results are given in Table 1.

Table 1. Vitamin B_{12} contents of different sewage sludges, of a sewage protozoan, and of cow dung (in micrograms of B_{12} per 100 g of the material).

Total B_{12} activity	Alkali-stable activity	True B_{12} activity (by difference)
	Raw sewage solids	
17.29	0.82	16.47
	Lime sludge	
30.48	24.72	5.76
	Alum sludge	
7.41	4.12	3.29
	Septic sludge	
32.13	22.24	9.89
	Activated sludge	
76.21	Traces	76.21
	Protozoa (Epistylis *sp.*)	
53.54	7.42	46.12
	Cow dung	
14.00	Traces	14.00

From these results it may be seen that, among the sludges, activated sludge contains the highest amount of B_{12}, although the figure given here is much lower than the figures reported for similar sludge (*1*). It is of considerable interest to note that the protozoan commonly found in activated sludge also contains an appreciable amount of B_{12}. The results also indicate the possible use of activated sludge as a supplement to the feeds of animals such as chicks and pigs.

S. SATHYANARAYANA RAO,
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H. N. BHAGAVAN, B. R. BALIGA
Department of Biochemistry,
Indian Institute of Science, Bangalore

References and Notes

1. S. R. Hoover, L. Jaseweiez, J. B. Pepinsky, N. Porges, *Science* 114, 213 (1951).
2. V. Kocher and U. A. Corti, *Schweiz. Z. Hydrol.* 14, 333 (1952); F. K. Mohlman, *Water & Sewage Works* 101, 54 (1954); H. Y. Neujahr, *Acta Chem. Scand.* 9, 622 (1955); ——, *ibid.* 9, 803 (1955).
3. S. R. Hoover *et al.*, *Sewage and Ind. Wastes* 24, 38 (1952).
4. We are much indebted to Dr. S. C. Pillai for his valuable suggestions in the course of this work. One of us (S.S.R.) thanks the authorities of the Indian Institute of Science for the award of the Sanat Kumar Ray Choudhury scholarship.
5. Skeggs *et al.*, *J. Biol. Chem.* 184, 211 (1950).

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(*Continued from page 238*)

dition is always implied; thus, 123 means 100 + 20 + 3. The proposed system incorporates the positional notion in the binary names, and thus we might suppose, if it is analogous, that thereafter addition alone is implied.

I trust the author will see fit to remove such ambiguities and prove that the resulting rules enable one to express any number, and that this representation will be unique for whole numbers.

DONALD B. HOUGHTON
Franklin Institute,
Philadelphia, Pennsylvania

With reference to the letter of Lawrence Rosler, the octal system is certainly more economical than the binary system for communication of large numbers. The hexadecimal system is still more economical and shares with the octal ease of interconversion with binary numbers. Neither of these, however, is a binary system. If I may apply the "ap"titude for naming digits with which the letter credits me, I suggest use of the name "eight" for the first power of eight.

Criticism of the term "one" has come to me also from F. T. Jung of Evanston, Ill. Jung suggests the French "un" as alternative. "Bit" implies a choice of two alternatives rather than unity. Changes such as those suggested can be considered if the system acquires formal recognition.

In regard to the letter of Donald B. Houghton, I can best reply by asking whether he would raise the question: "Does twenty-three thousand mean twenty + (three × thousand) or (twenty + three) thousand?" In the light of the above illustration, I do not understand the statement that "in the decimal system the named digits have values dependent upon their position and thereafter addition is always implied. . . ." The statement appears to confuse symbolic representation of numbers with naming of numbers.

A few examples will demonstrate the unambiguous application of the rule for naming binary numbers: In hiapdag, ap is smaller than dag, hence ap multiplies dag; hi is larger than apdag, hence hi adds apdag. Applying the same rule to bruonedag, one is smaller than dag, implying multiplication; bru is larger than one, hence bru and one add; bruone is smaller than dag, hence bruone multiplies dag. The rule works equally well from the most significant end. Thus, in the number 11,1100,1011, aponehicidbrudagcidapone, ap adds one; apone multiplies hi; aponehi adds cid and bru; cidbru multiplies dag (. . . hicidbru cannot mulptily dag because it is larger than dag); cid, ap, and one add together and add to the preceding. Thus we get: (ap + one) hi + (cid + bru) dag + cid + ap + one.

The other question raised, that of assuring unique representation of whole numbers, is beyond the scope of my proposal. I am not convinced that such rigidity is desirable. Certainly it does not exist in the decimal system, where one has the choice, for example, of "billion" or "thousand million" and of "twenty-two hundred" or "two thousand two hundred." I doubt that such rigidity can be imposed by rules. If rigid uniqueness is desirable, I prefer that it develop through usage, or that it be established by official groups.

JOSHUA STERN
National Bureau of Standards,
Washington, D.C.

Meetings

Reticuloendothelial System

The 3rd International Symposium on the Reticuloendothelial System was held in Rapallo, Italy, from 28 through 31 August. As with previous meetings, every attempt was made to keep the numbers of participants small and to have all participants reside in a single hotel or villa to provide the best possible communication both during and in between official sessions.

Seventeen nations were represented and 62 scientists participated. Simultaneous translating apparatus was available for all participants. Support for the American investigators attending the symposium was received from Baxter Laboratories, Burroughs Wellcome and Company, Geigy Pharmaceuticals, Hoffmann-La Roche, Charles Pfizer and Company, Schering Corporation, Wallace Laboratories, and Warner-Lambert Pharmaceutical Company. Several national and international pharmaceutical firms in Italy, as well as Esso Standard Oil, Mobil Oil, and Shell Oil, and the Italian Ministry of Education, provided funds and facilities for the symposium.

The papers covered a wide range of subjects including morphology, antibody synthesis, host defense mechanisms, properdin, steroids, shock, endocrines, radiation, isotope techniques, tumors and leukemia, phagocytosis, inflammation, cholesterol and lipid metabolism, radio frequency, and clinical manifestations.

Many of the data presented opened completely new areas of investigation, and many novel techniques of far-reaching implication were presented. These ranged from methods of selectively isolating reticuloendothelial cells to the production of new colloids and of unusual effects on reticuloendothelial cells in vivo by radio frequency. Considerable important information on the sequence of events in antibody synthesis was presented by numerous authors; this included cellular transformation and specific rates and methods of incorporation of amino acids into antibodies.

Interesting new data on substances such as polypeptides, lipids, lipopolysaccharides, dextrans, and humoral factors and their relationship to the reticuloendothelial system were presented. Natural and synthetic corticoids and steroids and their interrelation with reticuloendothelial system function were explored, as well as the role of the reticuloendothelial system in neoplasia and leukemia. The effectiveness and utility of new colloids, both inert and radioactive, were demonstrated, not only as new experimental methods but also in terms of their utility in human clinical diagnosis. The discussions covered lipid metabolism, including the role of the reticuloendothelial system in cholesterol metabolism, hyperlipemia, xanthomatosis, atherogenesis, and nephrosis.

The meeting was deemed to be highly successful and informative; the proceedings will be published by the Ronald Press, New York. The great advantage of a small, intimate meeting, away from a major urban center, was reaffirmed by the participants.

JOHN H. HELLER
Reticuloendothelial Society, New England Institute for Medical Research, Ridgefield, Connecticut

Forthcoming Events

March

1–2. Pennsylvania Acad. of Sciences, Gettysburg. (K. Dearolf, Public Museum and Art Gallery, Reading, Pa.)

1–5. Gas Turbine Power Conf., Cincinnati, Ohio. (O. B. Schier, ASME, 29 W. 39 St., New York, N.Y.)

7. American Chemical Soc., Oklahoma Div., tetrasectional meeting, Tulsa. (J. W. Conant, ACS, Grand River Chemical Div. of Deere and Co., Pryor, Okla.)

8–9. American Broncho-Esophagological Assoc., Hot Springs, Va. (F. J. Putney, 1712 Locust St., Philadelphia, Pa.)

8–9. American Laryngological Assoc., Hot Springs, Va. (J. H. Maxwell, University Hospital, Ann Arbor, Mich.)

8–12. Aviation Conf., Los Angeles, Calif. (O. B. Schier, ASME, 29 W. 39 St., New York, N.Y.)

10–12. American Laryngological, Rhinological and Otological Soc., Hot Springs, Va. (C. S. Nash, 708 Medical Arts Bldg., Rochester 7, N.Y.)

13–14. American Otological Soc., Hot Springs, Va. (L. R. Boies, University Hospital, Minneapolis 14, Minn.)

13–15. Alabama Acad. of Sciences, Auburn. (H. M. Kaylor, Dept. of Physics, Birmingham-Southern College, Birmingham, Ala.)

14–15. Southwestern Soc. of Nuclear Medicine, 4th annual, New Orleans, La. (S. B. Nadler, SSNM, 1520 Louisiana Ave., New Orleans 15, La.)

15–20. American College of Allergists, San Francisco, Calif. (M. C. Harris, 450 Sutter St., San Francisco.)

16–19. American Assoc. of Petroleum Geologists, Soc. of Economic Paleontologists and Mineralogists, 44th annual, Dallas, Tex. (W. A. Waldschmidt, AAPG, 311 Leggett Building, Midland, Tex.)

16–20. American Inst. of Chemical Engineers, Atlantic City, N.J. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

16–20. National Assoc. of Corrosion Engineers, 15th annual conf., Chicago, Ill. (NACE, Southern Standard Bldg., Houston, Tex.)

16–20. Western Metal Exposition and Cong., 11th, Los Angeles, Calif. (R. T. Bayless, 7301 Euclid Ave., Cleveland 3, Ohio)

17–19. National Health Council, Chicago, Ill. (P. E. Ryan, 1790 Broadway, New York, 19.)

18–25. International Social Science Council, 4th general assembly (by invitation), Paris, France. (C. Levi-Strauss, Secretary-General, International Social Science Council, 19, avenue Kleber, Paris.)

19–21. Society for Research in Child Development, NIH, Bethesda, Md. (Miss N. Bayley, Laboratory of Psychology, National Inst. of Mental Health, Bethesda 14, Md.)

23–26. Institute of Radio Engineers, natl. conv., New York, N.Y. (G. L. Haller, IRE, 1 E. 79 St., New York 21.)

24–27. American Meteorological Soc., general, Chicago, Ill. (K. C. Spengler, AMS, 3 Joy Street, Boston, Mass.)

27–28. Michigan Acad. of Sciences, East Lansing. (D. A. Rings, Univ. of Michigan, Dept. of Engineering, Ann Arbor.)

28. South Carolina Acad. of Sciences, Columbia. (H. W. Freeman, Dept. of Biology, Winthrop College, Rock Hill, S.C.)

29–3. Latin American Congress of Chemistry, 7th, Mexico D.F., Mexico. (R. I. Frisbie, Calle Ciprès No. 176, Zone 4, Mexico, D.F.)

30–1. American Orthopsychiatric Assoc., San Francisco, Calif. (M. F. Langer, 1790 Broadway, New York 19.)

30–12. Bahamas Medical Conf., 7th, Nassau. (B. L. Frank, 1290 Pine Ave., W. Montreal, Canada.)

31–2. American Power Conf., 21st annual, Chicago, Ill. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

31–2. Symposium on Millimeter Waves. 9th, New York, N.Y. (H. J. Carlin, Microwave Research Inst., 55 Johnson St., Brooklyn 1, N.Y.)

31–5. International Committee of Military Medicine and Pharmacy, 21st session. Paris, France. (Comité International de Médecine et de Pharmacie Militaires, Hôpital Militaire, 79, rue Saint Laurent, Liège, Belgium.)

April

1–3. American Assoc. of Anatomists, Seattle, Wash. (B. Flexner, Univ. of Pennsylvania Medical School, Philadelphia 4.)

1–4. National Council of Teachers of Mathematics, Dallas, Tex. (H. T. Karnes, Dept. of Mathematics, Louisiana State Univ., Baton Rouge 3.)

1–4. National Science Teachers Assoc., 7th natl. conv., Atlantic City, N.J. (R. H. Carlton, NSTA, 1201 16 St., NW, Washington 6.)

1–4. Neurosurgical Soc. of America, Hot Springs, Va. (F. P. Smith, 260 Crittenden Blvd., Rochester, 20, N.Y.)

1–29. World Meteorological Organization, 3rd session of congress, Geneva, Switzerland. (WMO, Campagne Rigot, 1, avenue de la Paix, Geneva.)

2–3. Electrically Exploded Wires, conf., Boston, Mass. (W. G. Chace, Thermal Radiation Laboratory, CRZCM, Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass.)

2–4. Association of American Geographers, 55th annual, Pittsburgh, Pa. (J. E. Guernsey, 9707 Parkwood Dr., Bethesda, Md.)

2–4. Association for Computing Machinery, Cleveland, Ohio. (J. Moshman, Corporation for Economic and Industrial Research, 1200 Jefferson Davis Highway, Arlington 2, Va.)

2–4. Optical Soc. of America, New York, N.Y. (S. S. Ballard, Dept. of Physics, Univ. of Florida, Gainesville.)

3–4. Eastern Psychological Assoc., Atlantic City, N.J. (C. H. Rush, Standard Oil Co. of New Jersey, Rockefeller Plaza, New York, N.Y.)

3–5. American Soc. for the Study of Sterility, Atlantic City, N.J. (H. H. Thomas, 920 S. 19 St., Birmingham 5, Ala.)

(See issue of 16 January for comprehensive list)

Equipment

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science does not assume responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed appears on page 286.

■ RESISTANCE THERMOMETER uses a silicon diode reference-voltage supply for the d-c measurement bridge. Reference voltage variation is less than 0.2 percent for a ± 15 percent change in line voltage. Temperature range is – 200° to 1200°F. Operating power requirement is 120/240 v, 50 to 60 cy/sec, 15 w. (General Electric Co., Dept. 586)

■ EVENT RECORDER records duration of events from 0 to 15 sec across a 7-in. horizontal axis on an 8½ by 11 in. sheet. Time of occurrence of each event is recorded along the 10-in. vertical axis for recording periods up to 48 hr. The unit can record either a continuous trace or a dot at the terminus of each event. Input signals close the circuit for the duration of the event. (Mast Development Co., Dept. 604)

■ PYROMETER scans a remotely located surface and presents a temperature profile on a cathode-ray oscilloscope. Surface temperatures within the range 50° to 1000°C are measured. Precision is ± 1°C or ± 2 percent, whichever is larger. (Radiation Electronics Corp., Dept. 607)

■ DIGITAL RATIOMETER measures ratios from 0 to 1.000. Input voltages range from 0 to 6.3 v a-c and 0 to 6 v d-c. With high-impedance input, acurracy is ± 0.1 percent of full scale. Nominal frequency for a-c measurements is 400 cy/sec; variations of ± 2 cy/sec are permissible. Reference input impedance is 1000 ohm; signal input impedance is 20 megohm for the a-c section and 10 megohm for the d-c section. (Performance Measuring Co., Dept. 591)

■ GAS-POWERED TIMING UNIT is designed for use with instruments requiring chart records for periods from 1 hr to 30 days. Compressed gas consumption is 5 ft^3/hr at 5 $lb/in.^2$. All parts exposed to gas are made from aluminum or stainless steel. The clock is self-starting and is not affected by wide fluctuations in supply pressure. (American Meter Co., Dept. 612)

■ POWER SUPPLY is designed for activating and electrically balancing thermal-conductivity sensing cells. Normal voltage output is 17 v with current between 30 and 500 ma. Regulation against input a-c voltage changes between 100 and 130 v is better than 0.25 percent. Response time is less than 25 μsec. (Industrial Instruments Engineering Corp., Dept. 615)

■ LOW-TEMPERATURE CABINET, cooled with Dry Ice, is available in two sizes with work space dimensions 24 by 24 by 24 and 18 by 16 by 20 in., respectively. Temperature range is + 200° to – 120°F. A thermostatically controlled blower mounted in the Dry-Ice compartment forces CO_2 into the working chamber as cooling is required. Temperature is controlled ± 0.5° at – 100°F and ± 1° at + 200°F. Time required to reach – 100°F is approximately 90 min; maintaining this temperature requires 2 to 2.5 lb of Dry Ice per hour. (American Instrument Co., Dept. 601)

■ CHROMATOGRAPHY COLUMN for preparative chromatography, manufactured by LKB-Produktor of Sweden, is capable of separating gram quantities of materials that are separable on a microscale by paper chromatography. A roll of chromatographic paper is used as the column filling. The paper is wound tightly in ready-made rolls around a central polyethylene sheath. A pressure mantle, inflatable by hand pump, surrounds the filling, holds it in place, and removes any inhomogeneity that may be caused by irregular swelling of the paper. (Ivan Sorvall Inc., Dept. 603)

■ GALVANOMETER AMPLIFIER provides gain of 250,000 with noise level less than 0.025 μv r.m.s. The signal is fed to the galvanometer, deflecting the light beam reflected from the galvanometer mirror.

The light passes through a splitter lens to twin photocells. The difference in the output of the photocells detects the deflection of the galvanometer. Drift is less than 0.1 μv over an 8-hr period. Dynamic range is 70 db. Linearity is ± 2 percent from noise level to 75 percent of the clipping level. (Geotechnical Corporation, Dept. 613)

■ TORSION TESTER determines the stiffness characteristics of nonrigid plastics over a wide range of temperatures. The tester is capable of exerting a torque of approximately 0.1 to 1.0 in. lb. The specimen under test is immersed in a circulated heat-transfer medium (Custom Scientific Instruments, Inc., Dept. 588)

■ SHOCK-TEST MACHINE is capable of reproducing shocks encountered in jet and missile flights as well as acceleration bursts resulting from vibrations and other transient conditions. It is also capable of reproducing normal shocks such as those encountered in handling and shipping. The machine provides a specified terminal-peak saw-tooth pulse shape rising to 100 *g* in 6 μsec. The shock response spectrum is flat from 80 to 1000 cy/sec. Anvil, carriage, and superstructure are isolated from one another. (Avco Manufacturing Corp., Dept. 618)

■ RARE-EARTH METALS — praesodymium, neodymium, terbium, holmium, thulium, ytterbium, and lutetium—are available from inventory in commercial quantities. Ingots are 1, 1.5, 2, 3, and 3.5 in. in diameter. Purity is greater than 99 percent. (Michigan Chemical Corp., Dept. 609)

■ VACUUM-BAKING OVEN is a heat-insulated chamber with temperature control equipment and a vacuum pumping system. The front flange of the chamber attaches to a box, filled with inert gas, in which semiconductor components are manufactured or assembled. The components are placed in the chamber, which is then evacuated to 10^{-6} mm-Hg and heated to 450°C. Upon completion of the bake, the vacuum is broken to the inert-gas atmosphere of the dry box. (F. J. Stokes Corp., Dept. 610)

■ TEMPERATURE SENSOR is designed to permit air-temperature measurements substantially independent of solar or other radiation. The thermally sensitive element is surrounded by an inner shield of stainless steel with a high surface-to-mass ratio. Surrounding this is a second cylinder, of aluminum. A third hat-shaped element reduces solar-radiation error. An aspirating blower is integrally mounted. Maximum temperature deviation is said to be 0.2°F. (Beckman & Whitley, Inc., Dept. 611)

JOSHUA STERN

National Bureau of Standards

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POSITIONS WANTED

Bacteriologist, B.S. (chemistry); M.S. (physiology major); Ph.D., bacteriology major; mycology minor; 9 years, chief bacteriologist, large teaching hospital; on faculty medical school as instructor. Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

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Pharmacologist-Physiologist, Ph.D.; 6 years' experience in most laboratory procedures including radioisotopes. Desires position in academic or industrial research. Box 14, SCIENCE. X

Ph.D., February 1959. Experienced in enzymology. Interested pharmacology, physiology, or biochemical research. New York, Connecticut, New Jersey. Box 11, SCIENCE. X

Scientist Ph.D., whose research program in aging and heart disease is receiving considerable financial support from granting agencies requires source of personal income. Box 10, SCIENCE. X

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Biologist to head scientific staff of growing, established biological supply house. Field collecting experience, plus knowledge of preserving and other biological techniques necessary. Ph.D. degree desired. Administrative ability and teaching experience required. Paid vacations, holidays, benefits, salary opportunities. Box 8, SCIENCE. 1/23, 30; 2/6

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Applications are invited for the position **Assistant Professor of Biology** to give instruction in physiology, embryology, and histology. Opportunities for research are available. The salary scale is $5400–$7000. A contributory pension scheme is in operation. Moving expenses are payable by the university to a maximum of $750. Applications containing a complete curriculum vitae and the names and addresses of three referees should be sent to the Head, Department of Biology, Memorial University of Newfoundland, St. John's, Newfoundland. 1/23, 30

Biologists, Ph.D.'s, new state college, southern California. Prefer background in physiology, genetics, embryology, microbiology, or botany. Please send full résumé to Ralph Prator, President, San Fernando Valley State College, Northridge, California. 1/9, 16, 23

Biologist. Experienced teacher of general biology, genetics, botany; small undergraduate northeastern liberal arts college for men; prefer Ph.D.; academic year 1959–60; salary dependent on training and experience. Box 21, SCIENCE. X

Botanist, Ph.D. Liberal arts college. $5400–$6500. Annual raises. Union College, Barbourville, Kentucky. 2/6

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This position offers an unusual opportunity and long-range financial security to the man or woman who can qualify. He or she must have a good academic background in biology and be thoroughly familiar with modern micro-technique methods; must have had considerable experience in making microscope slides (zoological and parasitological) in quantity for a university or a commercial laboratory; must be able to plan and direct the work of three or four assistants; will be expected to head and plan the long-range objectives of an important division of a large commercial laboratory. Preference will be given to applicants who are not more than 40 years of age.

The starting salary is in the $7000 to $7500 annual range, and ultimate financial advancement will compare favorably with the annual salary earned by the chairman of a university department of biology. Benefits include annual paid vacations, generous sick leave, medical and hospital insurance, life insurance, and retirement pension which pays up to $350 per month for life after age 65.

Applicants are invited to write and send complete data to

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(a) Neurophysiologist and, also **Endocrinologist;** important research posts, major company; Midwest. **(b) Pharmacologist,** Ph.D. to conduct research independently in fields of inflammation, analgesia or sympatholytic drugs; 14-year old company expanding into entire field of cosmetics and allied items; laboratory staff of over 125; opening also for **Histochemist** to conduct independent research; Ph.D. required; salaries up to $10,000; Midwest. **(c) Ph.D.'s in Biochemistry and Pharmacology;** experience in proteins helpful but not essential; latter should be experienced in physiology and pharmacology; both candidates should possess administrative experience; starting salaries, $14,000. **(d) Recently Graduated Ph.D. in Chemistry or Biochemistry** interested gastrointestinal problems; title is assistant professor; considerable research. S1-5 Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

THE UNIVERSITY OF LIVERPOOL

Applications are invited for Imperial Chemical Industries Research Fellowships in Physics, Chemistry, Biochemistry, Engineering, Metallurgy and Pharmacology or any related subjects. Appointments will date from 1st October, 1959. The salary will depend upon qualifications and experience, but will normally be within the range £800–£1,000 per annum, together with F.S.S.U. benefits and family allowances.

Applications, three copies, stating age,, details of qualifications and experience, publications, research work in progress and completed and an outline of the proposed field of research, together with the names of two referees, should be received not later than 14th February, 1959, by the Registrar, from whom further particulars may be obtained. (Candidates overseas who find it more convenient to do so may send 1 copy only by air-mail.)

POSITIONS OPEN

MEDICAL WRITER

Opportunity available for young physician in Professional Service Department of Medical Division. Should have ability and interest in medical writing. Clinical or laboratory experience desirable. Please send complete résumé to:

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New World-Wide Graduate Award Directories for American scientists, teachers, librarians to subsidize their education and research. Stipends $200–$10,000. Volume I (1957), $3; volume II (just published, no duplication), $3; both volumes, $5. Limited editions. Complete, specific information on 400 awards in United States and overseas in each volume. CRUSADE, Sci., Box 99, Station G, Brooklyn 22, N.Y. eow

Pharmacologist. 1 March teaching assignment, southern state-supported pharmacy school. Box 18, SCIENCE. X

The University of Alberta, Department of Physics, invites applications for the position of **Cosmic Ray Physicist,** at the level of assistant professor, effective 1 September 1959. Applicants must have a Ph.D. degree with postdoctoral research experience. An established mountain observatory at Banff, Alberta, offers facilities for research work.

Initial salary will range from $7000, according to qualifications and experience. A removal grant is normally made for married persons.

Applications for this position should include a **curriculum vitae,** transcripts of record, a recent photograph, and the names of three references.

Applications and testimonials should be sent to Professor H. Grayson-Smith, Department of Physics, University of Alberta, Edmonton, Canada. X

Postdoctoral Traineeships in Lipid Chemistry are available for 1959 at the University of Tennessee Medical Units, Memphis. The program offers persons holding Ph.D. and M.D. degrees an opportunity to learn modern analytical techniques in lipid chemistry, including the use of radioactive isotopes. Applications may be sent to Dr. D. B. Zilversmit, Department of Physiology. 2/6, 13

Postdoctoral Traineeship in Neuropharmacology Available for the Ph.D. in chemistry, biochemistry or pharmacology or the M.D. who would like to broaden his training and enter research in neuropharmacology. Stipends from $4500 per year and up plus dependent allowance. Postdoctoral fellowships in other areas, such as biochemical pharmacology, antibiotics, energy and drug enzymology, are also available. Write Chairman, Department of Pharmacology, Washington University School of Medicine, St. Louis 10, Missouri. 1/9, 16, 23, 30, 2/6

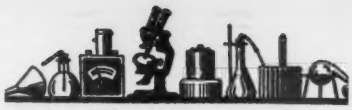
SCIENCE TEACHERS, LIBRARIANS, ADMINISTRATORS urgently needed for positions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives complete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, $1.00. Yearly (12 issues) membership, $5.00. CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. ew

FELLOWSHIPS

Research Fellowships in biochemical pharmacology are available for qualified individuals to study for Ph.D. degrees. A background in chemistry is desirable. Stipends begin at $1800 per year, plus dependent allowance. Write Chairman, Department of Pharmacology, Washington University School of Medicine, St. Louis 10, Missouri. 1/9, 16, 23, 30; 2/6

SCHOLARSHIPS

TISSUE CULTURE COURSE. The annual course in Principles and Techniques of Tissue Culture sponsored by the Tissue Culture Association will be given at the University of Colorado Medical Center, Denver, 6–31 July 1959. A limited number of participants (postdoctoral research workers, and teachers) can be admitted. The course will be directed by Dr. John Paul of Glasgow University. For further information and application forms, address Dr. Mary S. Parshley, College of Physicians and Surgeons, 630 West 168 Street, New York 32, New York. Tuition $100. Deadline for application, April 1, 1959. 2/20



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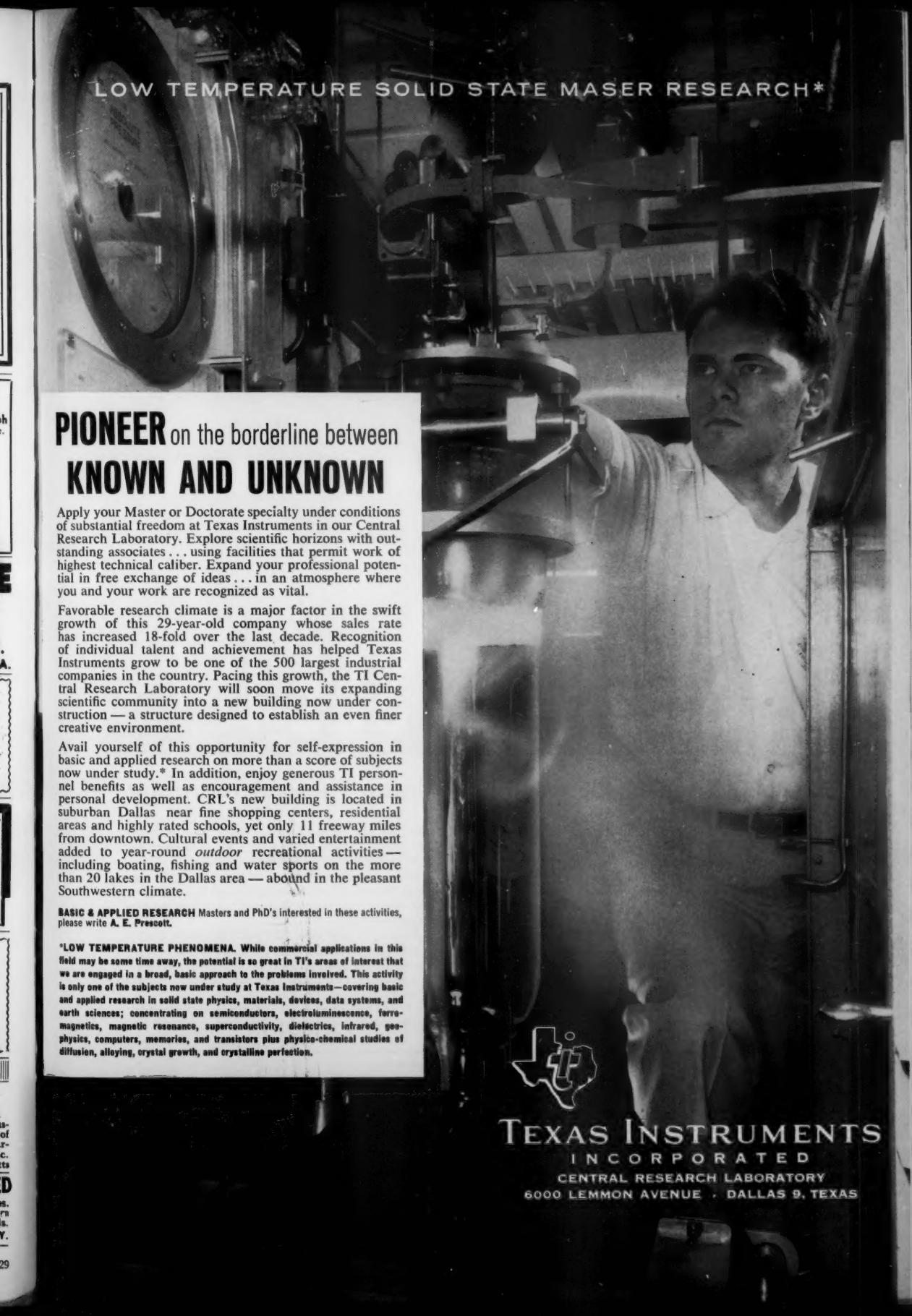

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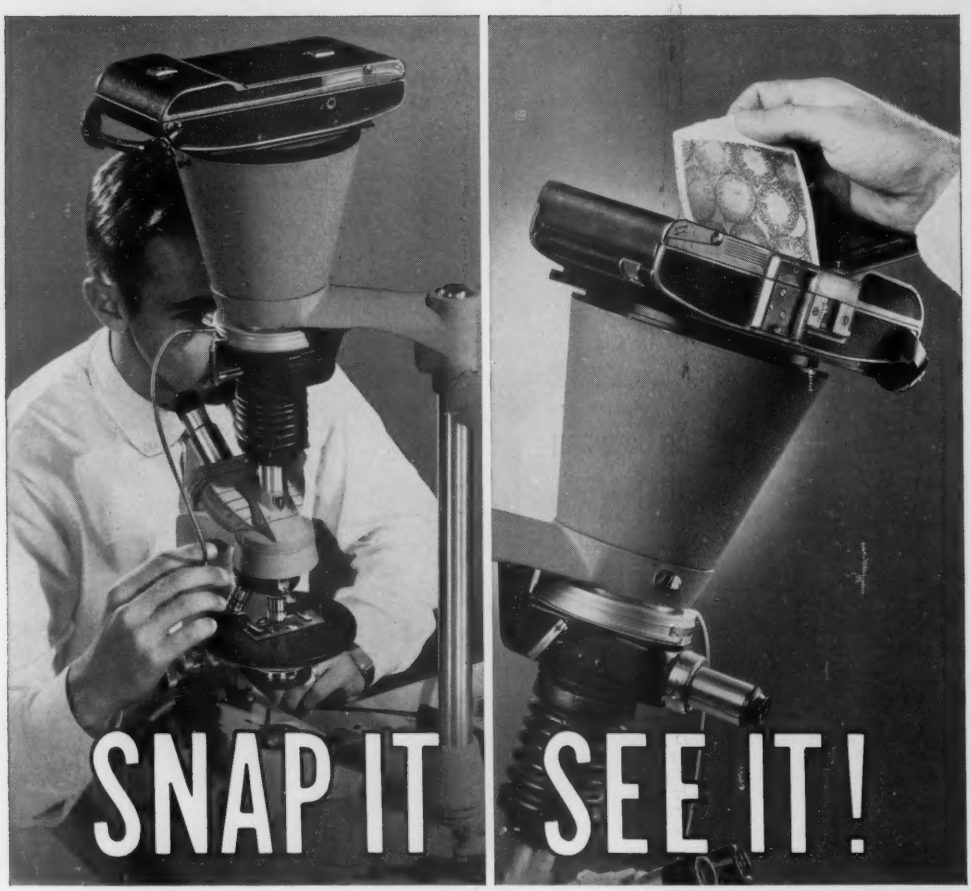

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